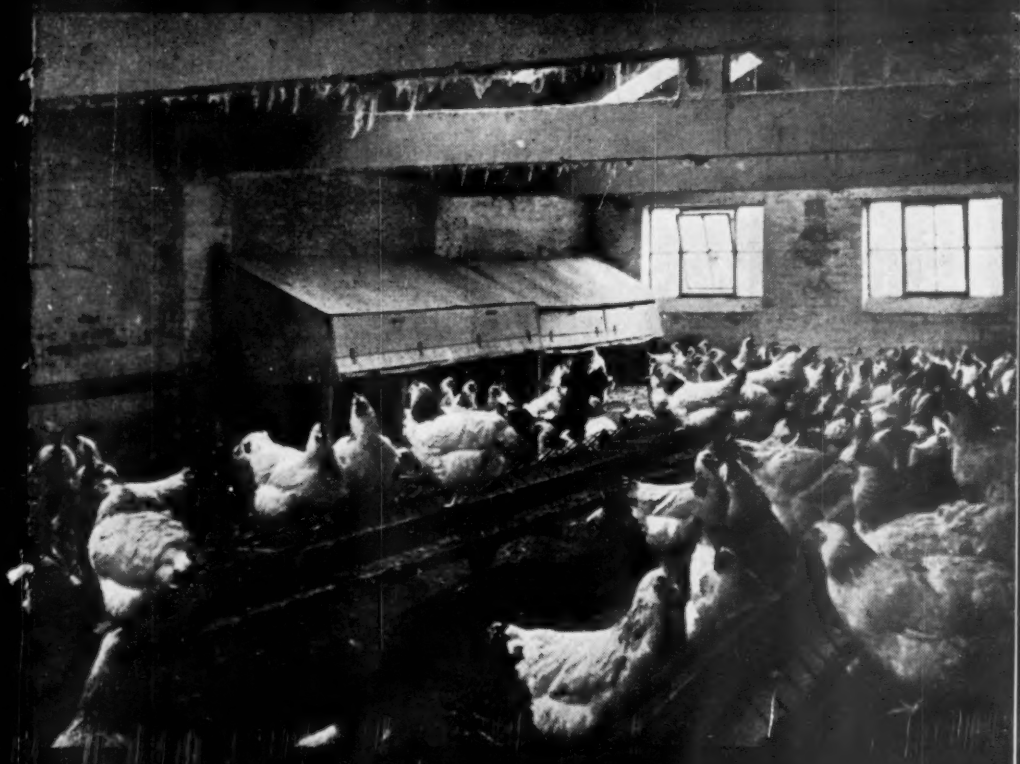
Agriculture



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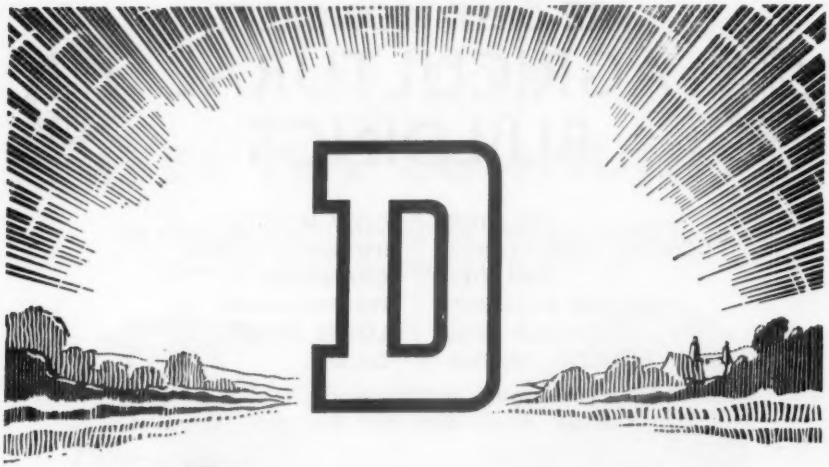

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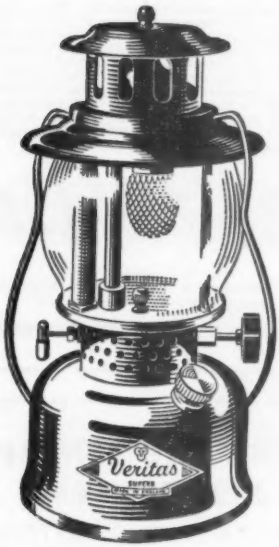

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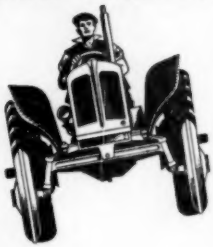

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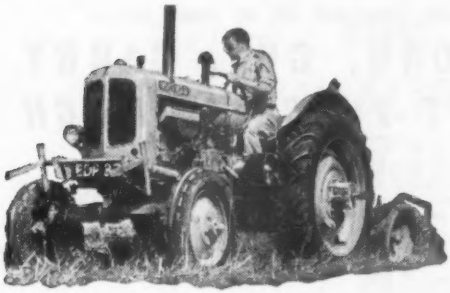

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VOL. LIX No. 11 FEBRUARY 1953

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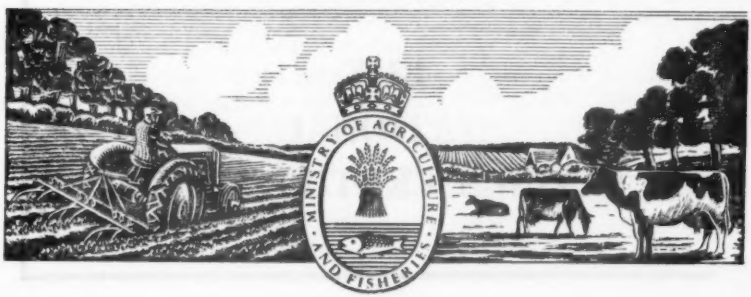
Contents

	Page
Research for Plenty : No. 4. The Desert and the Sown. *E. W. Russell*	503
The Post-War Pattern of Horticulture in England and Wales. *C. E. Pearson*	508
Experimental Horticulture Stations : Review of Progress. *C. E. Hudson*	516
Lengthening the Rotation on a Westmorland Farm. *G. D. Salmon*	520
Materials for Deep Litter. *R. Coles* and *A. R. Preston* ..	524
Some Effects of Farm Mechanization. *D. J. Griffiths* and *G. P. Wibberley*	527
Farm Buildings at the Grassland Research Institute. *N. E. B. Elgar*	532
High Protein Feeding Barley. *H. Hunter*	536
Farming Affairs	540
Book Reviews	545

Cover Photograph

Deep litter house set up on the first floor of an unused farm building on Mr. Jim Sutton's farm in Lancashire



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VOL. LIX No. 11 FEBRUARY 1953

RESEARCH FOR PLENTY

No. 4. THE DESERT AND THE SOWN

E. W. RUSSELL, M.A., PH.D.

Department of Agriculture, University of Oxford

DURING the last one hundred and fifty years, European settlers have crossed the world's divides and opened up for agriculture areas of sparsely inhabited but easily cultivated land. Only a century ago the United States, Canada, Australia, New Zealand, and the Argentine were making little contribution to the world's supply of food—countries that today are all large producers of the kinds of crops that Europeans grow to eat. And most of this expansion has taken place with very little help from the scientist—it was the achievement of the European immigrant, using European methods of farming, though sometimes with undesirable long-term effects. But, unfortunately, this great expansion has virtually come to an end, because there seems to be so little suitable land left. Increasing the area of land on which plants may grow is much more difficult now, for the problem is to grow them under conditions that defy our present European techniques.

Let me, at the outset, give you a few figures on the proportions of the major land regions in the world. About one-sixth of the land surface is desert; another sixth is in the Arctic and Antarctic, with permanently frozen subsoil; and another sixth is mountainous. So nearly half of the land appears unsuited to any productive kind of present-day farming. Of the remaining half, something under one-third is in forest, just under a sixth is in grass—but most of this in areas too dry or otherwise unsuited to intensive agriculture—and, finally, under one-tenth is actually tilled. Even this meagre tenth varies enormously in the initial endowment of its soils and the climate that geography ordains, so that it depends in a greater or lesser degree on farming skill and patience.

I think the agricultural problems of utilizing these areas can be put into three classes—combating cold or frost, combating drought or lack of water, and combating poverty of soil or plant food.

I will not describe the methods being devised for combating cold, as these have been suggested earlier by Dr. Ashby,* and they largely come within the province of the Russian and Canadian plant breeder. The problem of combating drought falls more within the province of the soil scientist, and is a threefold problem—making the clouds give more rain to the land, making the best use of the rain that does fall, and using other sources of water, namely, irrigation.

**Agriculture*, December, 1952, 401-5.

Irrigation by River Water Let me begin with irrigation; that is to say, taking water, usually from a river, and spreading it over the cropped land, as has been practised in Egypt and Mesopotamia for at least 5,000 years. Irrigation is always spectacular in a desert. Why then do we not set to work to irrigate all the deserts of the world? The reason is simple; we haven't the water in slow yielding quantity, unless we have mountains and melting snow. And we haven't always the contours for impounding this water where it is most wanted. Even if the quantity of water in the rainfall area is originally large, as, for example, in Northern Queensland, it may get used up or evaporated en route.

Let me take Egypt as a good example of water limiting irrigation. Almost the whole of Egyptian and Sudanese agriculture is based on the waters of the Nile, and the amount of land they can irrigate is determined not by the amount of suitable land but by the amount of Nile water that is available. In fact, for several months each year, when the flow of the Nile is low, the river ceases to reach the sea ; all its water has been used for irrigation. However, better use *could* be made of its waters because, when it is in flood, much of the water flows into the Mediterranean. Hence, great dams, such as Assouan, have already been built, and more are projected, to hold back as large a part as possible of the flood waters so they can be released later on when they can be used more profitably.

Lack of river water and absence of dams is one factor that limits the area of desert that can be irrigated. Salts are another. All river waters contain salts dissolved in them, so that when the water is spread on the land, salt is put on also. But whereas the water is evaporated by the crop, most of the salts dissolved in it are left behind in the soil, and if there is too much salt in the soil, crops cannot grow. Hence, rivers whose waters are brackish, or brackish underground well water, cannot be used for irrigation. Let me use the Indus as an illustration. This river irrigates several million acres of desert in the Punjab and Sind, but it may leave behind up to two tons per acre of salts in the surface soil each year. Now it will not take many years of salt accumulation at this rate before the land becomes sterile. Therefore, the scheme can only be permanent if the salts are regularly removed from the soil. This can be done if two conditions are fulfilled: the soil must be kept permeable and well-drained; and enough extra water must be applied at regular intervals to wash out these surface salts into the drains. Thus we see that irrigation, which is costly enough in itself, may often entail the additional cost of drainage. It is a matter of history that the arid regions of the world have already been littered with irrigation schemes that have come to grief because the salts were not properly controlled.

Other Sources of Water for Irrigation It is interesting to speculate on sources of water other than rivers that can be used for irrigation. In some places, ground water is near enough to the surface to be worth pumping, but this occurs only where it is fed from neighbouring, well-watered hills. Otherwise it is apt to be too salty. Another source of water is the sea, but it is very saline, and it could be used only if the salts were first removed. One way of doing this would be to evaporate the water from the sea, collect the vapour, and let it condense. This is a process needing a large amount of energy, but it could theoretically be obtained from the sun's radiation in desert regions. Another method by which salts can be removed from sea water is by using the cation and anion exchangers developed during the war to enable aeroplane and ships' crews in lifeboats to drink sea water. The sea water is poured in at the top of a column of the

exchanger and drinking water comes out at the bottom. But after a time the exchanger must be regenerated in the way that domestic water-softening plants need regeneration. Unfortunately, acids and bases are needed for this process, and their manufacture from the natural salts again needs large amounts of energy, possibly as much as is needed for evaporation.

I will not therefore pursue this matter but will leave the thought as a problem for our grandchildren. In any event it does not seem that the extra area of desert or semi-desert that we can bring into cultivation by irrigation is large. I think rather that we must look to our methods of farming the semi-arid regions and, by making better use of low rainfall, bring our cultivated areas still closer to the actual desert.

Improving the Efficiency of Dry Farming

One of the main characteristics of semi-arid, or dry farming as it is usually called, is the uncertainty of the rainfall. In Britain, we are used to a maritime climate where 30 inches of rain means roughly what it says—about 30 inches every year. But in the middle of continents and on the edge of the monsoons, one year the rain will fail and with it the crops, while in another it will be relatively bountiful, and so also will be the crops. Hence, crop yields themselves are far more variable than we in this country are accustomed to, and complete crop failures such as have occurred in the groundnut scheme are not necessarily the sign of bad farming.

It will help us to understand the possibilities for improving the efficiency of dry farming if we understand why plants need water, for, as you know, they can grow only if they have an adequate supply of water. Plants seem to need water primarily to keep their leaves cool, in the same way that our bodies are kept cool in hot weather by sweating. Plants differ amongst themselves very considerably in their ability to withstand drought. Most of the crops we grow in this country have leaves that are fairly easily killed if they are not supplied with adequate amounts of water, either because they would get too hot in the midday sun, or because the hot, dry air around them would dry out their living cells. There are however, some semi-desert plants, such as the sorghums and some millets, whose leaves can withstand drought conditions. They are not killed by high temperatures and they are so constructed that it is very difficult to remove the water from their living cells.

The efficiency with which crops can use water can be increased by reducing the movement of air around the crop. A drying wind, like the Khamsin or Chinook, which is always a feature of semi-arid areas some time in the year, can make crops transpire a great deal of extra water. Windbreaks or shelter-belts of trees and shrubs that give a solid wall of vegetation, reduce the speed of the wind over the crop for about a distance of twenty-five times their height on the downwind, and five times their height on the upwind, side of the belt. Such belts can be seen around some fields in East Anglia that are subject to dry easterly winds in the spring. This method of planting shelter is being used on a much larger scale in parts of the semi-arid regions of both North America and Russia. But shelter-belts have the limitation that they use a great deal of water themselves, so crops cannot grow close to them. In addition, the trees and shrubs composing them will suffer severely if there is a run of dry years, unless they have been carefully selected first for drought tolerance.

Besides increasing the efficiency with which a crop can use water, we can increase the amount of water available to the crop by ensuring that all the rain that falls on the land soaks into the soil where it falls, and that, as far

as possible, only the crop takes it out of the soil. This raises three problems: getting the water into the soil; preventing it being lost by evaporation from the uncropped soil ; and preventing weeds instead of the crop using the water. In theory it is easy to kill weeds by cultivation, as we do in Europe, but cultivations tend to dry out the surface of the soil and to leave it loose and dusty. Again, much of the rain that falls in these semi-arid areas comes in very heavy storms, and the impact of the fast-falling rain-drops on bare, loose, fine soil will turn it into liquid mud in a matter of seconds. This mud soon blocks all the drainage channels in the soil—hence soil erosion. The way of preventing this from happening is to protect the surface of the soil with a living crop or the dead remains of the preceding crop, so that the vegetation takes the impact of the rain-drops (much as the leaves of forest trees do), and only gently flowing water touches the soil surface. The great technical difficulty of keeping dry land covered is, on the one hand, to grow a crop heavy enough to cover the land surface, and, on the other, to prevent weeds from growing ; and it is for this reason that the use of weed-killing sprays may be found useful for water and soil conservation in the future. Incidentally, a cover of dead crop residues reduces very considerably the amount of water lost from the bare soil by evaporation.

Yet another method of conservation is to plough the land in contours so that the rainwater cannot so easily flow down the hillsides. Contour ploughing is already becoming a distinctive feature in the New World landscapes, and farmers are subsidized to have their land surveyed for this purpose.

However, all these methods for protecting the soil need either living crops or the residues of previous crops, and will become quite ineffective after a few consecutive dry years. If this happens, as it did in the Dust Bowl of America in the mid-thirties, there seems little we can do by soil conservation practices to prevent water erosion, and particularly erosion by wind and dust storms. This is something on the debit side we must always contend with: something which certainly went on when the bison and Indian roamed the Great Plains.

The Problem of Soil Poverty

The last type of area I want to mention is that of extreme soil poverty, such as exists in large tracts of the rain forests in the Amazon basin and in West Africa. Here are millions of acres of adequately watered land, but so poor in plant foods that cropping is almost impossible. Forests, as Sir James Scott Watson has already pointed out in his article in this series, do not necessarily mean fertile soils.

In theory, we ought to be able to cultivate this land continuously, and grow good crops on it, provided we can maintain an adequate supply of plant food in it. We may be able to do this, to some extent at any rate, firstly, by selecting and breeding varieties of plants whose roots have a much greater ability to extract plant food from soil particles than have most of our present crops, and, secondly, by returning to the soil all available plant and animal wastes. But it is probable that these methods alone will not be adequate to keep such lands in continuous cultivation. Fortunately, the principal nutrients required by crops—nitrogen, potassium, phosphates, calcium and magnesium—are all available in ample supply, and should last for several millenia, even with our present-day techniques and knowledge. The principal problem is more likely to be the fuel supply necessary to convert the raw materials into efficient fertilizers, though there is no reason to suppose

that we will not be able to devise methods for carrying out this conversion with a much less expenditure of energy than we need at present.

Already the supply of fertilizers holds out hope for the future of poorly endowed soils. In Britain, where former forest soils have been leached of nitrogen by continuous rainfall, the increased use of nitrogen alone has led, in the last hundred years, to progressive improvements in crop yields. Broadbalk, the classic plot at Rothamsted where wheat has been grown continuously for 109 years, bears out this claim for nitrogen alone. In the same way, in New Zealand, phosphate, fortunately available in the Pacific, enabled the wild white European clover to establish itself on the pastures, while in parts of Western Australia wheat could not be grown without it. Again, a spectacular piece of contemporary development is the Ninety Mile Desert in South Australia where the major plant fertilizers themselves were of no benefit until infinitesimal traces of copper and zinc were added, and found to turn sour, barren scrub into productive farmland. Here was no costly or spectacular irrigation scheme or forest clearance, but a virtual transformation depending on a few pounds of minerals that the wind-blown seaboard soils apparently lacked—a catalyst that was able to start up the whole process of grassland production and animal health. There are other soils in the world that can be brought to a state of fertility by scientifically correcting the same imbalances in their endowment, for we must not forget that a soil is the product of its parent rock and its climatic history. Soil is not actually necessary for the plant ; it can be nurtured artificially by solutions of chemicals in an anchorage of gravel, as enthusiasts in hydroponics have shown. But if we are to use the vast area of earth over which the sunlight falls, the farmer must so regulate the air, water and minerals in his fields that the area on which plants may flourish can be extended.

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THE POST-WAR PATTERN OF HORTICULTURE IN ENGLAND AND WALES

C. E. PEARSON
Ministry of Agriculture and Fisheries

Mr. Pearson here considers some of the more important changes affecting the present-day market for horticultural produce, and offers some suggestions of interest to growers thinking about the future of their industry.

SEVEN years mark but a short period in horticultural time, yet the years since 1945 show that the industry has made considerable progress in the task of settling down from its war-time expansion to levels better suited to more normal times. The period is long enough to test the permanence of new forms of production and crop utilization and judge the main changes in consumer tastes, and so to give a broad picture of the present pattern of the industry and indicate the trends of future developments. It is long enough, also, to provide fairly reliable averages of area and production, information on seasonality and imports and to even out the variations which inevitably occur from year to year, thus enabling comparison to be made with similar averages in pre-war years.

Consumer Demand It is often forgotten that all the main changes in the type or size of horticultural production have been dictated by consumer requirements. And although the consumption of fruit and vegetables can never be expressed in exact terms, because wastage between the field and the table cannot be accurately estimated, an "apparent" figure based on available total supplies averaged over a number of years can be obtained and used with some reliance as an indication of consumer demand.

During the war, supplies of fruit, particularly apples, bananas and citrus fruit, were much reduced, but supplies of vegetables were increased by the expansion of home production. In the post-war period imports of vegetables quickly returned to their former proportions, but imports of fruit have been about one-third below the pre-war average, mainly because it has been impossible to buy freely in all the markets of the world. But since home production has increased substantially, total fruit supplies (from both home and overseas) have been only some 10 per cent below the pre-war figure, although the markets have still been short of bananas and citrus fruit and have not had such a wide spread of supplies over the whole year. Apart from this, the consumer has had complete freedom of purchasing ever since the war-time controls on prices and distribution were taken off. And it seems clear that whilst the demand for high quality and good value for money is now as strong as it was during the 'thirties, tastes are very different and are already exercising a great influence on horticultural cropping.

Such changes must from their very nature be gradual and for this reason can be discerned only over a period of years. In trying to measure them, it is important to sort out the causes which have only a temporary influence from those which are of a more permanent nature and are indicative of future requirements. The former are only too well known, the best example being that sudden change in weather which spoils the salad market and gives a temporary boost to the demand for vegetables for cooking. Of the latter, the most important are those consumer preferences which persist over a number of seasons, and the production from allotments and private gardens.

It is clear from all available records that whilst the consumption of fruit and vegetables as a whole has increased slowly but steadily since the beginning of the century, almost all the well-marked preferences for individual products have eventually reached a peak where demand remains constant and then moves on to a different product. For example, the consumption of apples showed an increase for twenty or thirty years, then remained steady, and bananas and oranges began to increase in popularity. Only tomatoes have kept up an unbroken increase for more than fifty years. The conclusion must be that whilst the peak of consumption for all fruits and vegetables put together has not yet been reached, there is a peak for every individual product which must inevitably set a limit to its commercial production.

Domestic Production Immediately after the war there was a not unexpected fall in the number of allotments and gardens given over to food production. But recently there has been a marked revival and the total number of allotments is once again over a million, with an estimated production of half a million tons of vegetables. No figures exist to show what may be the output from private gardens, but it is safe to assume that when the number of allotments increases, the area devoted to food crops in private gardens also increases. Their importance to the professional grower is that they produce appreciable quantities of summer vegetables and the commoner types of winter vegetables and that their greatest production occurs in good-growing years, thus reducing demands at the markets when the commercial horticulturist has heavier crops than usual.

VEGETABLES

The average area of vegetables grown in the open during the years 1940–45 was approximately 320,000 acres, or about 70,000 more than the pre-war average. The area continued to increase and reached its peak in 1948 (380,000 acres). For the past two years it has been almost constant at around 290,000 acres, or some 40,000 acres more than before the war. In addition, there have also been marked changes in the proportionate areas of the different crops. The war-time expansion consisted mainly of increases in carrots and peas for canning (roughly 100 per cent), cabbage, cauliflower and lettuce (40 per cent), and sprouts (20 per cent), with spectacular rises in the comparatively small areas of such crops as outdoor tomatoes and onions. Since the war, only peas for canning have increased further (being now about 200 per cent above their pre-war average), carrots have fallen to 70 per cent, cabbage to 30 per cent and cauliflower to 20 per cent, while lettuce and sprouts remain at or near their war-time figures. Green peas for the markets (not for canning), which generally maintained their pre-war area right up to 1950, have fallen in the past two years to 30 per cent below, and although onions and outdoor tomatoes now occupy only half the average war-time areas, they are still about five times above the pre-war levels. Celery and turnips are 50 per cent below. Rhubarb is slightly above its pre-war area, having declined from the peak of 1950.

On average yields, an area of 290,000 acres is sufficient to maintain the pre-war rate of consumption after taking account of the rise in population. In a good growing season it would create a surplus, and in a poor season a shortage; but unless consumption rates can be raised, there appears to be no necessity to increase the area. On the other hand, it is clear that the area should not be further reduced, because consumers still draw at least four-fifths of their total supplies from the home grower; and since production still fluctuates widely from year to year, any smaller acreage might well result in

the sort of scarcity that too easily leads to all the evils of high prices and rising acreages, which in turn lead to low prices and falling acreages. Nor should there be any sudden or wide changes in the areas of the individual crops which make up the total, since consumer taste changes slowly and it is invariably the grower who suffers most from this kind of switching.

Bearing in mind the present extent and nature of production in allotments and private gardens, it would seem that the existing areas devoted to summer vegetables such as peas, beans, lettuce and cabbage, and to the main root crops are sufficient to meet demand. The areas of carrots and turnips may still be too high. Among the winter vegetables there will clearly be sharp competition between sprouts and cauliflower, for the past few years have shown that the one which is of the better quality seriously affects the market of the other. Unless, therefore, the two crops are well grown and are spread over as many weeks as possible by the judicious selection of varieties, there is likely to be some danger of uneven supplies. All other crops which are normally grown on comparatively small areas, for example, celery, and the specialist crops like asparagus and rhubarb, have never enjoyed more than a limited or seasonal demand, and even small changes in their areas might well have disturbing results unless some new outlet or some increase in consumption can be assured.

GLASSHOUSE CROPS

It is impossible to do more than make a very broad comparison between glasshouse cropping today and that of earlier periods because the pre-war statistics gave few details, whilst during the war cropping was controlled and production varied from year to year as large areas were destroyed or put out of action and many houses on private and municipal estates turned over to food crops. The significant point is that in the last seven years the area has increased steadily to just over 4,560 acres of glasshouses and approximately 600 acres of lights, or roughly 1,500 acres and more than 300 acres respectively above the 1939 figures.

Tomatoes remain the most important crop and since the war have averaged nearly 3,000 acres, with an estimated production of 94,000 tons, compared with a pre-war average of 1,800 acres and 68,000 tons. Imports, including winter supplies from the Canary Islands, have averaged 204,000 tons, as compared with 142,000 tons, so that total supplies from all sources have been running at nearly 300,000 tons a year—almost 90,000 tons more than before the war. A hundred years ago, tomatoes were still newcomers to the markets, but their rate of consumption has risen steadily ever since. Somewhere lies the peak, and it is clear that the rate of increase in the area of glass over the last seven years cannot safely be continued indefinitely. It is true that the rate of expansion in the past two years has been much less than the high rates of 1948–50, but in the last twelve months no less than 68 acres have been added to the total. And although it is also true that the area devoted to tomatoes fell steadily between 1945 and 1951 as that of flowers increased, 1952 has seen a reversal and there are signs that flowers are now decreasing and tomatoes increasing. Under normal conditions tomatoes have always occupied between two-thirds and three-quarters of the total glass area, which means that even at the low national average yields, every extra 50 acres of glass is likely to add over 1,000 tons of tomatoes to annual market supplies. Moreover, with the high cost of fuel and the increasing proportion of new houses erected without heating apparatus, there is a growing danger that production will be concentrated into the middle and latter parts of the season.

The post-war records of cucumbers show that the area has averaged some 60 per cent above the pre-war level, and although production is estimated to be only 35 per cent higher, it provides the consumer with some 7,000 tons more than before the war. In addition, imports, which formerly averaged less than 1,000 tons a year, have increased to about six times this figure. Lettuce, the most important of the winter glass-grown food crops, shows some sign of declining from the high levels of 1946–50, but still remains at well over double the pre-war average.

Of other glasshouse crops, mainly flowers, no comparison can be made with earlier years because no statistics exist and during the war production was severely restricted. It can be seen, however, that the area increased steadily after freedom of cropping was restored and that approximately 900 acres now carry flowers and foliage crops but, as stated above, there is some indication that the figure is likely to fall or at least to show no further increase.

It seems that for the future, the greatest care will be necessary in planning the cropping of glasshouses, in dividing the area among the widest possible selection of crops and in timing their production so that the cropping season may be spread over the longest possible period. The greatest pressure must inevitably occur with tomatoes, and unless home consumption can be further increased, the development of an export market seems imperative.

FLOWERS, BULBS, NURSERY STOCK

The areas of outdoor flowers, bulbs and nursery stock were compulsorily reduced during the war, and since they are all "long-term" crops, replanting has been comparatively slow. But it has been steady, and recent figures indicate that the pre-war levels are in sight. The area of nursery stock has been almost constant for the past three years and at roughly 10,500 acres is the same as before the war. Outdoor flowers appear to be settling at about 7,000 acres, or just over 1,000 more than in 1939. The area of bulbs is still increasing but is still nearly 1,000 acres below the 1939 area of 7,600 acres. There is no doubt that the restocking of private gardens, the Festival of Britain and the approach of the Coronation have encouraged these sections of the industry, but unless sales can be further increased the present acreages, except that of bulbs, would seem sufficient to meet normal demands and keep pace with the building programme.

TOP FRUIT

With the publication of the 1951 Fruit Census, it is now possible to get a much clearer picture of the changes that have been taking place in the growing of top fruit. Comparison with the earlier censuses of 1944 and 1936 not only shows certain well-defined trends but also—and this is more important—how long these tendencies have been running. The total acreage of all kinds of top fruit has varied little in the last twenty years, averaging about 260,000 acres, but there have been many changes in the areas and types of the different fruits within that total, and the steady decreases in the western counties have been matched by increases in the east and south-east. Production, which rose very gradually up to 1939, has since risen quickly and steadily, and the pre-war average of less than 500,000 tons a year has been replaced by a post-war average of more than 700,000 tons. And although variation in yield from year to year still persists, it has been appreciably reduced, except as regards plums.

Between 1925 and 1944 the total number of trees rose by nearly three millions, of which roughly two millions were planted between 1931 and 1936.

These are now in bearing and, with the all-round improvement in methods of production, are mainly responsible for the higher average yields of recent years. Between 1944 and 1951 the number of trees fell by just over one million although the area occupied fell by only 1,500 acres. But these and the more detailed figures of the censuses can only indicate the size and nature of recent plantings and grubbings. They cannot show where further planting may be wanted or not wanted unless production, improvements in growing, periods of supply and developments in marketing are taken into account and each kind of fruit is dealt with separately.

Apples Dessert apples, of which Cox's Orange Pippin and Worcester Pearmain now account for 70 per cent, have increased by nearly 1½ million trees to a total of 10 millions. Nearly 3 millions are under seven years' old and 7 millions under sixteen. Cooking apples have decreased by the same figure to 4½ millions; just over 300,000 are under seven and one million under sixteen. Production over the past ten years has averaged nearly 380,000 tons, or roughly double the figure for the years 1929–38. The increase has almost equalled the fall in imports, so that total supplies to the consumer have been nearly the same, although the varieties and the periods of marketing have altered considerably. And whereas imports have generally consisted of dessert varieties, home production still gives a preponderance of cooking varieties. The earlier statistics do not differentiate between the two classes, but over the past four years the proportions have been just under two-fifths of dessert to just over three-fifths of cooking varieties. And whilst the production of dessert varieties has greatly increased, and according to the censuses will continue to increase, the production of cooking varieties has tended to settle, with smaller supplies of early varieties offset by larger supplies of late varieties, and is unlikely to alter much in the immediate future. Even so, the average combined production for the next ten years will probably be somewhere between 425,000 and 450,000 tons and will be made up of up to 170,000 tons of dessert and 280,000 tons of cooking varieties. The main problem will be that of marketing more than double the pre-war quantity.

This must inevitably be a great task, but it has to be remembered that more than half the total will consist of long-keeping varieties, compared with less than one-third before the war; and whereas formerly the bulk of the crop had to be marketed over a period of from 20 to 22 weeks and not more than 30,000 tons could be held in store for any length of time, there is today sufficient long-storage space for some 100,000 tons and the effective marketing season has been extended by 12–16 weeks. In addition, the increase in population will, at pre-war rates of consumption, absorb an extra 30,000 tons. There should therefore be little difficulty in disposing of about one-half of the increased production. The other half may also find its market as long as import restrictions continue and provided it is of good quality, but it will undoubtedly meet considerable difficulties when normal international trading returns. The apple-grower's great task for the future will then begin. The only solutions appear to be the raising of the average standards of quality of the apples sent to market with the object of tempting the consumption rate to start moving up again, or the creation of an export trade. Neither of these objectives can be achieved quickly or suddenly. It seems, therefore, that bearing in mind both the age and number of the different kinds of trees, there should be no further increase in the area of apples, at least until new and outstanding varieties of very early or very late season come into common use. The one exception may be Bramley's

Seedling, where less than a quarter of the trees are under sixteen and less than a tenth are under seven years' old, and the rate of planting has dropped to about 20,000 trees a year. Assuming a 60-year life, the annual replacement rate to maintain the present area should be about 30,000. To maintain but not increase the existing area of other cooking varieties, the annual planting rate should be about 50,000 trees, and for all dessert varieties about 200,000 trees. The rates over the past seven years have averaged 24,000 and 400,000 respectively.

Pears Pears present problems rather different from those of apples. Total pre-war supplies averaged a little under 80,000 tons, made up of some 19,000 tons home grown and 59,000 tons imported. Since the war the total has averaged 124,000 tons, home production having risen to nearly 33,000 tons and imports to 91,000 tons. It is clear that consumer demand has increased substantially, and the home industry appears to be well-placed for the change. Since 1944 the number of trees has increased by 21 per cent to nearly two and a half millions, of which more than half are Conference. One-third are under seven years' old and over half are under sixteen. With the increased demand and the availability of storage, over-production is unlikely in the immediate future, but it is clear that production will continue to increase and, owing to the preponderance of Conference, marketing must inevitably be concentrated within a defined season. It is doubtful if there is room for any further increase of this variety. To maintain its acreage would demand a planting rate of about 25,000 trees a year, but in view of the high proportion of young trees this is probably too high for the next ten years or so. The rate over the past seven years has been more than 70,000 trees a year. For all varieties of pears the recent rate has been well over 100,000 trees—nearly three times the rate for maintenance.

Cider Fruit This presents some unique features. The decline in the number of trees which set in before the war has been continued. Between 1936 and 1944 the number fell by over 600,000, and between 1944 and 1951 a further fall of nearly 400,000 was recorded, leaving a total of just under two millions. Less than 10 per cent are under seven years' old and about 20 per cent are under sixteen. On the other hand, post-war production at 105,000 tons has averaged nearly 30 per cent above the pre-war average. But the conclusion must be that whilst production now and in the immediate future may well be sufficient or more than sufficient for requirements, there will follow a period of comparative shortage when the older trees die off and the present small number of young trees will be insufficient to compensate for this loss. To maintain the existing acreage, planting should be at the rate of some 30,000 trees a year, assuming a life of sixty to seventy years. Recent planting has been about 23,000.

Cherries Much of what has been said about pears applies also to cherries. Post-war consumption has averaged just under 30,000 tons a year (including 7,000 tons of imports) compared with a little under 13,000 tons (600 tons imports) before the war. Since 1944 the number of trees has increased by nearly 60,000 to 875,000. About 25 per cent are under seven years' old, and just over 40 per cent under sixteen. Although the season is concentrated, there is a wide choice of good quality varieties and most of them have their own well-defined cropping periods. Provided proper selection is made, there seems little cause for any reduction in planting, and a full maintenance programme of 10,000–15,000 trees a year may well be required for many years. The recent rate has been high—nearly 30,000.

Plums Plums present many problems. Average production over the past ten years was just short of 120,000 tons and compares with an average of 85,000 tons for the ten years 1929–38, or 101,000 tons for the five years 1935–39. Imports at just under 15,000 tons have been almost exactly the same as the pre-war average, about 50 per cent arriving during the home season. Total supplies have therefore been appreciably higher in spite of significant changes in the proportions of the different varieties grown. The total number of trees fell by nearly 300,000 between 1936 and 1944, and between 1944 and 1951 by nearly a million to less than five millions. Victorias have fallen by some 150,000 trees to just over one million, of which 193,000 are under seven and 444,000 are under sixteen years' old; damsons by just over 120,000 to 440,000, of which 74,000 are under seven and 168,000 under sixteen, and "other plums" by nearly three-quarters of a million to just under three millions, of which 373,000 are under seven and 920,000 under sixteen years' old. Gages on the other hand have increased by 112,000 trees to 364,000, of which 132,000 are under seven and 188,000 under sixteen. During recent years planting has been at rates which should maintain the area and production of Victorias and damsons, increase the gages and further reduce the other varieties. The total has averaged just over 100,000 trees a year, or nearly enough to maintain the existing area, and since methods of production have much improved over recent years it is probably sufficient and might be divided as follows : Victorias 20,000–25,000 ; Gages 10,000–12,000 ; Damsons 10,000–12,000 ; Others 50,000–60,000. But it should not be allowed to fall much below these levels, for although average production has increased, the range of annual variation still remains almost as great as ever ; before the war it ran from 20,000 tons to 160,000 tons, and since the war from 65,000 tons in 1950 to a provisional estimate of 200,000 tons in 1952. Years of scarcity will no doubt continue, but to provide for them inevitably means also to incur years of surplus. And there is little that the grower can do in the typically "bumper" year for the main cause of the heavy surplus then is the plum tree in the private garden ; it can easily provide for all the bottling and jamming in the average household, and if only one garden in ten has such a tree, market demands will be reduced by around 30,000 tons.

SOFT FRUIT

The decline in the area of soft fruit which set in after the First World War continued until 1945, when the total of a little under 30,000 acres was less than half that of the early 'thirties. By 1950 it reached just over 51,000 acres, but during the past two years declined again to just below 45,000, the fall last year being nearly 3,000 acres. Compared with the 1939 acreages, black currants show an increase of nearly 5,000 acres, and raspberries an increase of 100 acres. Strawberries have declined by nearly 3,000 acres, gooseberries by 2,000 acres, red currants by 1,000 acres, and loganberries and blackberries together by 1,000 acres. But the significance of these changes is materially altered when the figures of production are compared. For the five-year period 1947–51 the average was 67,500 tons from 44,500 acres. In the five years before the war the figures were 53,700 tons from 52,200 acres. In other words, soft-fruit growers now provide the consumer with nearly 14,000 tons more fruit than before the war and use nearly 8,000 acres less to do so. These are the significant figures, and they are a measure of the advances that have been made by the industry in its methods of growing. The one dangerous feature is the high acreage of black currants, for although the 1952 area is just over 1,000 acres less than the record of 1950, the steady expansion which continued from 1946 to 1950 can only mean that by far the greater part

of the area consists of young bushes, many of them not yet in full bearing. For this reason average production is likely to go on rising for the next few years. The present average is nearly 17,000 tons and may yet go to 20,000 tons, which will be well over 50 per cent above the pre-war average of home production and imports together. The present area of 15,000 acres could safely be reduced to 12,000 and the planting programme should then be not more than 1,500 acres a year.

It seems important that the present areas of the other kinds of soft fruit should be maintained; there may indeed be room for small increases. Although the strawberry acreage has fallen, it is common and welcome knowledge that the drop has been largely due to a reduction in the proportion of second-rate varieties, and that the better-class dessert varieties are on the increase. Annual imports now average just over 2,000 tons, or more than double the pre-war figure, and there seems no reason to believe that consumer demand has yet been completely satisfied. The area might be increased to about 18,000 acres, which would necessitate a planting programme of 5,000–6,000 acres a year. The maintenance or slight increase in the areas of gooseberries and raspberries would demand the annual planting of some 500 acres each.

CONCLUSION

The immediate future is likely to show an intensification of the main features of consumer demand as seen in the past few years and before the war. Large numbers of the industry's customers will continue to tend their gardens and allotments, necessarily concentrating on the crops and seasons most suited to private gardening, and any new preferences of a permanent nature are likely to centre round a wide choice of good quality produce of the kind that only the professional grower can offer. The grower must therefore aim at increasing his proportion of high-quality goods, at extending their marketing season and reducing the annual variation in yields. To succeed in this, he must be able to use equipment for irrigation, storage and the control of pests and diseases and, above all, to maintain the fertility of the soil. These are all costly items. If their use becomes unprofitable, production will fall and a larger area of land will be required to provide for the consumer's needs. If, on the other hand, their continued and increasing use is an economical investment, production will increase slowly but steadily and a compensating reduction in present acreages will be possible and even necessary unless consumption can be designedly increased or new markets created, both of which are inevitably slow processes.

For the present, the total acreage required to meet foreseeable demands for all types of horticultural produce appears to be about 600,000 acres, made up of some 250,000 acres of top fruit, 45,000 acres of soft fruit, 280,000 acres of vegetables, 5,200 acres of glasshouses and frames and 24,000 acres of flowers, bulbs and nursery stock. The total is some 80,000 acres less than the peak of 1948 and about the same as before the war. Production, however, would be about 35 per cent higher, and in this lies the greatest compliment that can be paid to the modern grower.

Correction

January, 1953 issue, "Fodder Beet for Pig Feeding," page 473. The figures given in Table 4 for Average cost of food per lb. liveweight gain should read : "14.0d., 14.3d., 15.2d., 14.9d."

EXPERIMENTAL HORTICULTURE STATIONS: REVIEW OF PROGRESS

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IN the last issue, an introductory account was given of the experimental stations already established and of the facilities which are being provided for experiments with horticultural crops. Something was also said concerning the general set-up and the care being taken to plan the experimental programme so that the fullest results are obtained with the land, staff and material resources available at the stations.

How essential this planning has been may be gathered from the fact that all the available land on some of the stations could have been swallowed up at the outset by both long-term and local projects without regard to the needs of future developments. The various Working Parties have adopted a policy of making haste slowly and, by consultation with advisers and close co-ordination of the Stations' programmes with research developments at the national research stations, the foundations have been soundly laid.

As has been explained, many experiments are of a long-term nature, often on a scale that would have been impracticable without the facilities at the new N.A.A.S. Stations. Some experiments are jointly planned for several different stations, and it will be possible to test on a full commercial scale under various climate and soil conditions the discoveries made at the national research stations. Although it may be some years before much information of practical value will be forthcoming from these trials, the contribution they are likely to make in the end should be all the more impressive for the care that has gone into the preparatory work. Meanwhile, growers and advisers may follow the progress of the work with interest and profit and, as a result, gain some information concerning the possible application of research findings to local practice.

Some of these long-term experiments are concerned with primary land usage, such as the cultivations experiments which follow a prototype laid down at the National Institute of Agricultural Engineering. The effect of various cultivation practices on the land and crops will be examined—such as deep and shallow ploughing, discing, rototillage and hand digging. Full provision is also being made for irrigation experiments with vegetable crops, both on open and intensive systems, and later on it may be extended to fruit growing.

Many experiments are concerned with trials of standard and new varieties, and these are co-ordinated on a national basis in conjunction with the N.I.A.B. for vegetable varieties, East Malling and Long Ashton Research Stations and the National Fruit Trials for fruit varieties, and the John Innes Horticultural Institution and Cheshunt Research Station for glasshouse crops.

Fruit Naturally, a great many of the fruit experiments are long-term. At the main stations for fruit experiments at Luddington, Efford, Stockbridge House and, in due course, in East Anglia, the full programme will occupy some 70 acres of land at each station, and the planting of carefully raised and standardized trees and rootstocks is proceeding as quickly as possible.

Fruit varietal trials have already been planted in the last year or two, and in a few years' time experience of varietal behaviour under local conditions will begin to come in from different parts of the country. These trials cover promising new varieties of tree and soft fruits which are being tested against standard varieties under the National Fruit Trials scheme, the main centre of which in the past twenty-five years or so has been at the Royal Horticultural Society Gardens, Wisley. These central trials are now in process of transfer from Wisley to the new site at Faversham, Kent, and the Experimental Stations will in due course operate as local sub-stations to the Faversham centre in respect of varietal trials. The central trials will also be concerned with the initial testing on a smaller scale of recently raised or introduced varieties undergoing "screening" tests. There will also be a very comprehensive national collection at Faversham of tree fruit and soft fruit varieties, running into many hundreds of varieties in the case of the main tree fruits, for purposes of reference and classification.

Other long-term experiments with fruit on such matters as rootstock trials, pruning, tree nutrition and soil management systems are planned for apples, pears, plums and a range of soft fruits at all the main stations. There will also be investigations on fruit diseases and pests, and spraying and cultivation machinery tests.

As examples of co-ordinated experiments which are well under way at the stations, the critical trial of selected stem-building varieties for the control of Bacterial Canker in stone fruits may be mentioned, and on the nutritional side, a manurial experiment with black currants in which the effects of different rates of NPK fertilizer dressings on the growth and cropping of selected varieties will be compared.

Of shorter term experiments, a trial of systemic insecticides for strawberries is in operation at Luddington and will continue for a year or two before findings are published. It is hoped that this may throw light on the problem of controlling the insect vectors of virus diseases, and so help with the problem of maintaining healthy stocks for propagation.

At Stockbridge House, a number of experiments of local interest are being started, with the object of answering the question whether the area is suited to top fruit production or what are the limitations. Here, in a special trial, dessert and culinary apples and plums are being planted as bush trees on selected rootstocks with the object of discovering varieties particularly suited to the region.

There is also at Stockbridge a cropping test of selected damson varieties for hedgerow planting and use as windbreaks—a matter of particular interest in exposed parts of the north, where damsons are often used in this way. This raises the question of the lack of reliable information on shelter-belts and screens and their effectiveness in protecting crops and assisting growth. A start has therefore been made on experiments with different types of screens and windbreaks in consultation with the Meteorological Office. At stations such as Rosewarne (Cornwall) with special problems of exposure to ocean winds, there are excellent opportunities for work of this nature.

Another instance of the importance attached to local problems can be given from the West Midlands. Cider orcharding is a quite important aspect of farming here, and some 40 acres of cider fruit will be planted in Herefordshire or a nearby county for experimental purposes. Experiments will include vintage variety and rootstock trials, and the examination of management practices in cider plantations and orchards.

With plans projected for future cultural experiments and disease investigations, whole new orchards have been planted and reserved. Meantime careful measurements of growth and cropping variations are being recorded in "calibration trials", so that the fullest possible information on soil and site variability may be accumulated before the experiments begin.

Glasshouse Work As with fruit crops, if for quite different reasons, long-term experiments are a main feature of the glasshouse work. This is well shown by the forethought given to long-term plans, particularly in relation to glasshouse design, structure and heating. The fact that there was very little existing glass on any of the new glasshouse stations has been turned to good account, for as glasshouses are put up on the new sites, features of novel design, construction and constituent materials are incorporated for comparison with traditional structures and practice.

At Fairfield Sub-Station, where glasshouse erection has been able to proceed most rapidly, a range of separate vinery-type houses of standard softwood timber construction are being compared with a similar house in which new Empire hardwoods have been used. Trials are also in progress to find out the results of timber preservation with various preservative compounds, both by pressure treatment and dipping.

Features of novel design due to the experimental work and practical experiences gained at the John Innes Horticultural Institution are reflected in east-west orientated propagation houses, both at Fairfield and Stockbridge. Each house is in two sections—one with conventional even span roof, the other with uneven span with the object of increasing mid-winter light which is frequently the limiting factor in growth. Particular care has been taken to ensure that each section of the house has exactly the same area of roof-glass and the same interior cubic capacity.

In conjunction with the National Institute of Agricultural Engineering, comprehensive experiments on glasshouse heating and ventilation will be conducted at Fairfield. Comparisons will be made between low pressure hot water, steam, steam to water, and electrical heating. The last-named method is being used, not as a practicable method of space heating under present-day supply and price conditions, but because it makes possible the recording of the energy input in heating and ventilating glasshouses. The microclimatic and other conditions in blocks of houses will also be compared with those in single houses.

Other new structural features of the glasshouses take care of the need to economize in materials, reduce cost, or improve light conditions or to make mechanical tillage easier. The tensioning of purlins and gutters, and the use of R.S.J. construction in 30-feet wide houses, reduces the need for internal stays, ties and supports and gives a clear working space throughout the house.

Other variations in construction include: the use of 24-inch glass, gussetted construction at eaves and ridge to increase light, save timber and reduce cost, continuous light-alloy ventilator hinges, and a comparison of wood with metal alloy construction.

Under glass, very little is known about the variation in ventilation, temperature, humidity, light and other conditions of the microclimate in different parts of a glasshouse. Arrangements are therefore being made for comprehensive recording of these conditions, which may have profound effects on management and disease control. From the standpoint of the correct layout of glasshouse experiments, the calibration of plots is being undertaken with the object of discovering the variability due to such factors as

end and side effects in glasshouses, another subject on which more needs to be known in preparation for a full programme of experiments.

Meanwhile some preliminary experiments, mainly of local interest, are being undertaken. Thus, for example at Fairfield, the growing of lettuce in new glasshouse soil is of special interest to Lancashire glasshouse growers owing to the considerable losses suffered from this cause. The effects of dressings of lime, superphosphate, farmyard manure and the steaming of soil are all being tested in the hope of finding an answer to the problem. Spacing trials with winter lettuce are also of special interest to Lancashire growers, and both square and staggered planting from 6 inches square up to 9 inches staggered are being tried at Fairfield. So far it has been found that all but the 6-inch plantings have given marketable hearted lettuce using Cheshunt 5B. Further tests of size, quality and time of maturity are in hand.

At Luddington, experiments on *Botrytis* control in winter glasshouse lettuce were started, since this disease has given a good deal of trouble on some West Midland holdings. So far, there has been practically no *Botrytis* on lettuce at Luddington, and the key to this problem often seems to be good hygiene and crop management. Where conditions are good, it may well be that treatment to control *Botrytis* may cause more loss through checked growth and delayed maturity than would the risk of relatively small losses from the disease itself.

Apart from these local problems, a full programme of glasshouse experiments has of course been planned in connection with the production of the principal glasshouse crops. Once the building and other operations of initial development are out of the way and the early problems of glasshouse calibration and experimental layout solved, experimental development should quickly go ahead.

Flower Crops With flower crops, plans are not so far advanced except for bulbs. Experiences at the long-established centres in Lincolnshire and Cornwall have made their contribution, and it has been possible to draw up a programme of experiments on various aspects of bulb cultivation, which can go into full operation as land and facilities develop at the new station at Rosewarne in Cornwall, and the existing centre at Kirton, Lincolnshire. Long-term nutritional experiments, chemical and other weed control, strain-testing and varietal trials, pest and disease control are all included. In the future the extension of the work to include pre-treatment of bulbs and forcing for flower production must await the installation of special equipment.

With other flowers, a limited programme is being undertaken affecting flower production in general, but those crops of special commercial importance in particular. Most of the stations are in the early stages of assembling nuclear stocks of varieties, and looking into problems of propagating, cleaning up and establishing healthy stocks true to name.

Vegetable and Protected Cropping Apart from a fair number of short-term experiments of local interest, the lines developed most actively have included the varietal and strain trials of vegetables in conjunction with the National Institute of Agricultural Botany, and the experiments on chemical weed control in conjunction with the Unit of Experimental Agronomy at Oxford University. Spacing trials with vegetables, particularly onion, have also been started in collaboration with the National Institute of Agricultural Engineering to ascertain for the information of machinery designers the optimum drilling distances and seeding rates.

Experiments are also in progress or planned with crops under Dutch lights and cloches. These include the spacing of lettuces, strains of self-blanching celery, and soil warming. A long-term experiment has as its subject the orientation of Dutch light frames, with lights at different angles and running north-south and east-west; it is being run jointly by Stockbridge and Luddington, using winter lettuce as the experimental crop.

It is hoped that enough has been said to show that an encouraging start has been made with experiments on a wide range of horticultural crops and interests. Whilst the practical results are inevitably sparse up to the present, it can be seen that the formative years have been well spent in careful planning of a long-term programme, and a great deal of thought has been given by some of the best brains in research and advisory work to the problem of making the most of the land, equipment and men at the N.A.A.S. Experimental Horticulture Stations.

LENGTHENING THE ROTATION ON A WESTMORLAND FARM

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This article describes how a Westmorland farmer who, while recognizing the worth of the traditional rotation, is working out a system of cropping which will provide more stock food per rotation without departing from the rules of good husbandry.

IT may at first sight appear strange that in high rainfall areas of the north and west of England, where grassland farming predominates and the tillage area is of secondary importance in the farming system, the maintenance of a proper rotation of crops is regarded as a matter of prime consideration, while in the arable areas of the country rotations frequently depart from custom. In the wetter districts, however, arable land quickly becomes plough-sick due to excessive leaching, and the growth of annual weeds makes cleaning stubbles difficult. In these circumstances, the growing of two consecutive white crops is seldom regarded as the best practice. Oats, roots, oats undersown for a 3–7 year ley, is the traditional rotation that has proved its worth. It follows, therefore, that in areas where this rotation is regarded as indispensable, the acreage of tillage on any particular farm is strictly proportional to the acreage of roots that can be efficiently managed with the available labour.

The farm which is the subject of this article consists of 100 acres of uneven and steeply sloping land at altitudes varying from 250 feet to 600 feet above sea level. The soil is glacial drift—mainly medium, stony loam. The rainfall of the district varies from 40 to 50 inches. The climate makes the land eminently suitable for growing good grass, but tillage is a relatively expensive enterprise. The system of farming is typical of the district and consists of cattle and sheep rearing and the sale of surplus milk.

When the present tenant took the farm in 1934, 72 acres were classed as

"crops and grass", 28 acres as "rough grazing", and some 12 acres were under the plough. The stock on the farm consisted of 33 cattle and 35 ewes of the Rough Fell breed. The new tenant proceeded to take the plough round the farm, ploughing about 3 acres out of grass each year. With the outbreak of war, bigger acreages were ploughed until, in 1943, a peak of 30 acres under the plough was reached. By 1949, the arable acreage was stabilized at about 21 acres. Every acre ploughed out of grass was put through the traditional course of cropping before being reseeded to grass. By this time the stock on the farm had been increased to 60 cattle, 40 Masham-type ewes and their lambs, 3 pigs, 2 horses, and 185 poultry. The milking herd comprised 21 cows, the majority calving in autumn, but with a number of calvings taking place throughout the year so that a small, local, milk round could be supplied. All heifer calves were reared, and cows were usually sold after the third calving. The Masham ewes were crossed with a Suffolk ram to produce fat lambs.

By 1949, however, it had become evident that the days of abundant, cheap, imported animal feedingstuffs had gone, and that the war-time ideal of self-sufficiency had come to stay. This meant that the tillage area must be maintained and, if possible, increased at a time when the costs of labour, machinery, seeds and fertilizers were continually rising. The need for more home-grown coarse grains was urgent. On the other hand, rising costs made the accompanying increase in the root acreage appear a doubtful economic proposition. Clearly it was time to consider modifying the traditional rotation.

Introduction of the One-Year Ley

A possible solution to the problem presented itself by accident. The farmer was dissatisfied with the production of a 7-acre meadow and decided that it must be ploughed. This meadow had received heavy annual dressings of farmyard manure for many years, and it was highly probable that if oats were sown the crop would lodge. A further point was that when this type of old permanent pasture is ploughed a second time, quantities of unrotted turf are frequently brought to the surface and seriously hamper preliminary and inter-row cultivations for the root crop. A silage crop of oats, peas and vetches was therefore sown and undersown with a one-year ley so that the old turf would be buried for at least two years before the field was again ploughed. In early June 1950, a good crop of arable silage was taken, and abundant aftermath grazing was provided by the one-year ley. In previous years milk yields had invariably dropped when cows were turned on to the aftermath in this field, but in 1950 the milk production rose. The following year, in the second week in May, this field was cut for grass silage. Early in July about 6 tons of hay were taken and the aftermath grazed until well into the autumn before being ploughed. In 1952, 3 acres were sown with oats and 4 acres with roots, this being as much as the available labour could handle.

As a result of his experience with this meadow, the farmer decided to try a modification of the traditional rotation of the district. Land ploughed out of grass would be sown with oats, or a cereal-legume mixture, and undersown for a one-year ley. The one-year ley would provide grass silage or hay, and aftermath grazing. In succeeding years the land would be cropped with oats, roots, and oats undersown with a long ley suitable for staying down three to seven years. By this means it was hoped that each rotation would provide three crops of oats, two crops of seed grass for mowing and one root crop, as compared with two crops of oats, one crop of seed grass and one root crop provided by the old rotation.

In 1951, 3½ acres were sown with oats and a one-year ley. In 1952, 6 acres

were similarly sown, but the increased quantity of high quality grass provided by the one-year leys has encouraged the farmer to attempt a further intensification of production. In 1951, immediately after the hay harvest, 1½ acres from which hay had been taken were ploughed and on July 3 the land was broadcast sown with marrowstem kale. A further 3 acres were ploughed after the hay crop had been taken last year, and sown with kale on June 20. Although this kale crop was not as heavy as in 1951, the farmer is sufficiently satisfied with his experiment to have decided that each year he will plough approximately 2 acres of grassland and sow with kale in this way. The subsequent treatment of this land will be to sow with oats or wheat, undersown with one-year ley, to be followed by the usual rotation.

The purpose of the one-year ley is to provide a heavy crop of grass of high quality. On this farm it is preferred to take one good crop for hay or silage and to graze the aftermath with the dairy cows and young calves. In this way, the farmer aims at returning humus to the soil and so minimizing the risk of soil exhaustion. The seeds mixture used has been:

	lb. per acre
Italian ryegrass	8–10
Commercial perennial ryegrass ..	8–10
Broad red clover	6
Approximately ..	24

The quantity of red clover in the resultant sward has been disappointing, and ryegrass has accounted for 80–90 per cent of the herbage. Soil analysis reveals no lime or mineral deficiencies, and at the moment it would appear that this system of management is not favourable to the vigorous growth of red clover. It is possible that cultivated white clover might be a more suitable companion for the ryegrass.

For the longer-term leys, the Cockle Park type of mixture, based on ryegrass, cocksfoot, timothy, red clover and wild white clover, has stood the test of time in this district. This mixture, including a proportion of pedigree strains, is being used on this farm with good results. The leys are usually mown in their first year and subsequently grazed or mown according to their situation and the needs of the farm.

Manuring and Feeding This intensification of production has necessarily been associated with careful attention to manuring. Lime is applied as indicated by soil analysis. Phosphates and potash are given in relatively small quantities at frequent intervals. Fields to be mown for silage or hay receive farmyard manure in winter and, in spring, 3 cwt. per acre of a complete fertilizer containing nitrogen, phosphate and potash. Those fields intended for silage also receive 2 cwt. per acre "Nitro-Chalk", applied in early April. Pastures and long leys are dressed with about 10 cwt. per acre high-grade slag at intervals of approximately six years.

Normally, no fertilizer is applied to the oat crop. For potatoes and mangolds, farmyard manure is applied in the ridges, together with 10 cwt. per acre complete fertilizer. The mangold land receives, in addition, 4–5 cwt. salt per acre, applied about three weeks before sowing. For swedes, a dressing of 5–10 cwt. slag per acre is given in February, and 5–6 cwt. of a complete fertilizer immediately before the land is put into ridges. The broadcast kale crop receives 2 cwt. "Nitro-Chalk" per acre in the seedbed and a further top dressing of 1 cwt. per acre is applied one month after sowing.

Each year the farmer aims to mow about 30 acres of grass. Approximately

one-third of the crop is made into silage and the remainder into hay. As all the grassland is young, growth starts early and it is generally possible to secure crops of good quality hay in the middle of June. Grass for silage is mown during the first half of May and is ensiled in pits. The use of adequately manured leys for this purpose ensures that heavy crops are available at this time of the year.

In June 1952 the stock consisted of 22 Commercial Shorthorn cows and 42 followers, 50 Masham-type ewes, 2 breeding sows, 1 horse and 200 poultry. The position has now been reached where the land will support more cattle than can be housed in winter, and it seems that increased production will now depend on the provision of additional buildings.

The aim in feeding is to provide the dairy cows with a ration from home-grown foods sufficient for maintenance and one gallon of milk. Up to Christmas, kale and hay provide the ration, followed, in the New Year, by silage, hay, roots and oats. Balanced concentrates are fed at the rate of 4 lb. per gallon of milk in excess of the first. The target of maintenance and one gallon of milk from home-grown foods has been reached since silage was first made in 1949. The silage has been well made but is of moderate protein content. With better quality silage, there seems no reason why a higher degree of self-sufficiency should not be attained.

A High Degree of Self-Sufficiency

The history of this farm since 1950 has been an attempt to increase production in an area where the climate is pre-eminently favourable to the growth of grass by regarding grass as a crop in the same way that any good arable farmer regards his tillage crops. It is realized that young grass pays better dividends for generous manuring than old grass, and the plough is being used to prevent any grassland outliving its maximum usefulness. Since 1940, the whole of this farm, except for three fields totalling 12 acres, has been ploughed. Two of the untouched fields provide water supplies for adjoining land, while the third adjoins the buildings and is used as a turn-out for cattle in winter. Rough grazing no longer exists.

The value of the traditional rotation of the district is recognized, but it has been modified so as to provide one extra crop of oats and one of seed grass for mowing, without increasing the most expensive crop of the rotation—that is, the roots. The production of stock food has thereby been increased without increasing the labour force, which, since the beginning of the war, has consisted of one hired man and a youth.

Grass, converted into silage or hay, and kale provides home-grown protein, which is balanced with home-grown oats and roots to provide for maintenance and one gallon of milk. Prior to 1950, purchased concentrates were relied on to supply the whole of the production ration.

This increased measure of self-sufficiency and longer arable rotation has been accompanied by an increase in the number of stock carried throughout the year. All cattle are attested and the farmer holds a licence for the sale of T.T. milk.

It is not suggested that the ideal crop rotation has been achieved or that the perfect system has been discovered. The production of better-quality silage would probably open the way to a higher degree of self-sufficiency. The system of manuring may not be perfect, and it remains to be seen whether the fertility of the land can be maintained under the more intensive system of cropping. This account merely describes how one farmer is attempting, with apparent success, to increase his production in the face of limited labour supplies, rising costs and scarcity of feedingstuffs.

MATERIALS FOR DEEP LITTER

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What is the most suitable material to use for deep litter in this country? A recent trial indicates that chopped straw is of much greater value than was hitherto supposed: in fact, combined with shavings, it proved to be the most successful of the seven mixtures tested.

THE widespread interest in the deep-litter system of poultry-keeping has led to many inquiries about the most suitable material to use for litter. In North America, emphasis is laid on the need for dry litter, and the corn cob, bagasse (dry pulp from cane sugar production) and wood shavings which are commonly used, comply fully with this requirement. In Britain, however, wood shavings are often difficult and expensive to obtain, and success has not always attended the use of other materials. With the intention, therefore, of finding out the most suitable material for British conditions, the writers carried out trials with several different substances.

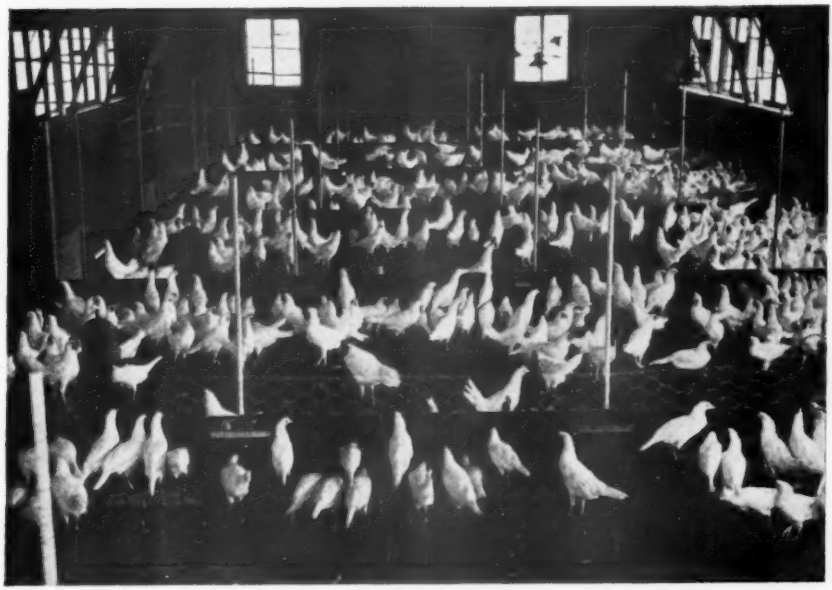
To ensure that environmental conditions were, as far as possible, identical, the experiment was carried out in a large cement-floored Nissen hut. This hut was divided into seven equally-sized pens of 10 feet by 25 feet. The experiment was begun on May 5 with day-old chicks, and the birds were reared and carried on in the pens until they were 15 weeks' old. It was thus hoped to cover a fair sample of English weather – both dull and rainy, and dry and warm. At the end of the period, the pullets were removed to another set of deep-litter pens having similar types of litter, and are being carried over a laying year. A report on the conditions of the litter in the adult pens will be made by the writers at the end of that experiment.

Seven types of litter were used; the composition of each was as follows:

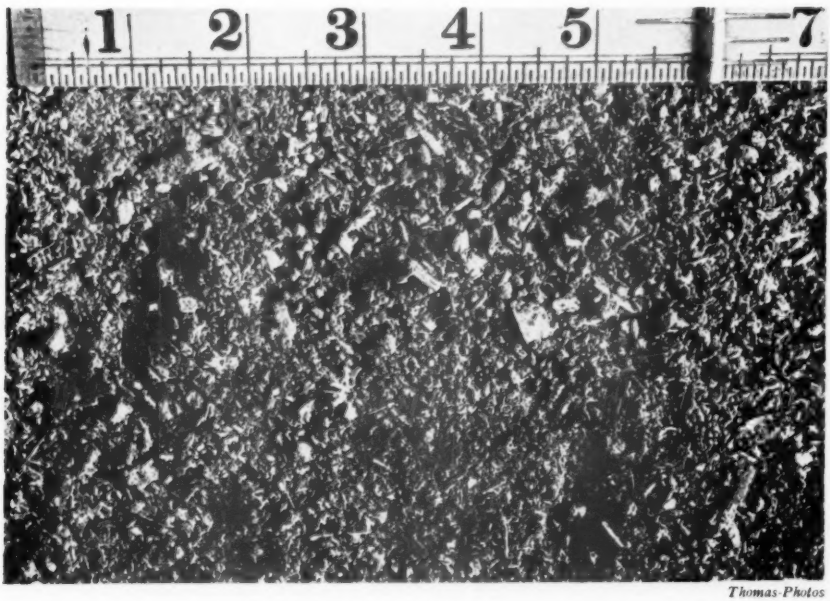
Pen	Type of Litter
1.	Sawdust and shavings (equal parts).
2.	Chopped straw and shavings (equal parts).
3.	Shavings over a 2-inch layer of fine, dry sand.
4.	Shavings over a scattering of hydrated lime (¼ lb. per sq. ft.).
5.	Shavings over a scattering of finely-ground oyster shell (¼ lb. per sq. ft.).
6.	Chopped straw over a scattering of finely ground oyster shell (¼ lb. per sq. ft.).
7.	Peat moss and sawdust (equal parts).

Day-old chicks of Single Comb White Leghorn breed were apportioned to each pen at a rate of approximately 220 (215–231) chicks per pen. The chicks were from closely related families, and a random selection from each family was allocated to each pen. The chicks were brooded by dull emitter infra-red lamps, which were raised to reduce heat as growth progressed and finally discontinued at six to seven weeks. Drinking fonts and food troughs were placed in the pens; as the chicks grew older, the troughs were raised and perches were attached.

Seven Litter Materials Compared The appearance of the litter material in all seven pens was very similar over the first few days except that in Pen 7, which was much darker in colour than the others. Marked differences soon became apparent and the development in each pen may be summarized as follows:



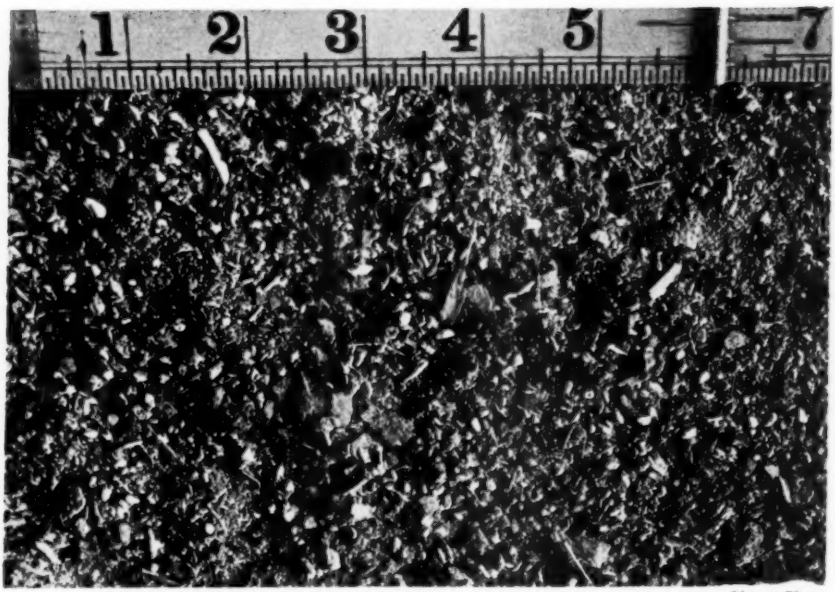
Site of the trials : seven pens. The following photographs of the various litter materials were taken at the end of fifteen weeks



Thomas Photos

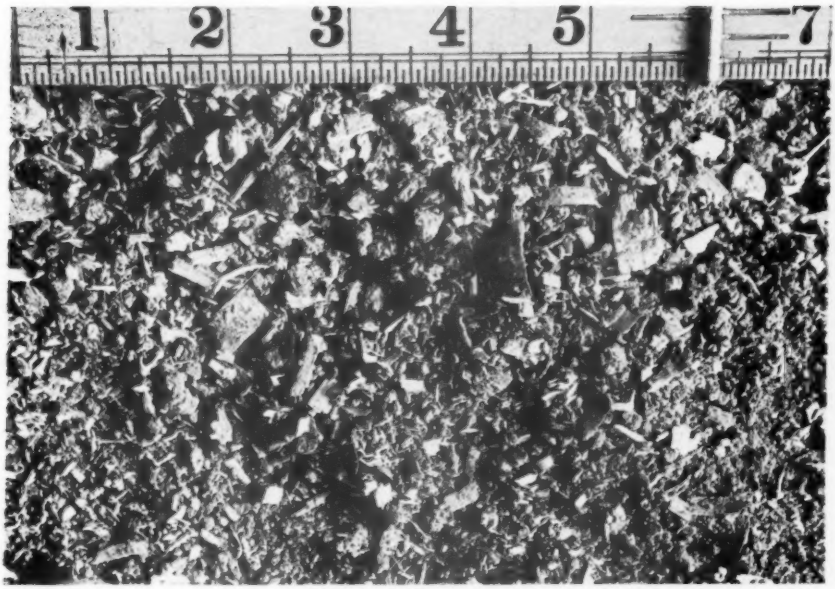
Pen 1. Sawdust and shavings

Pen 2. Chopped straw and shavings

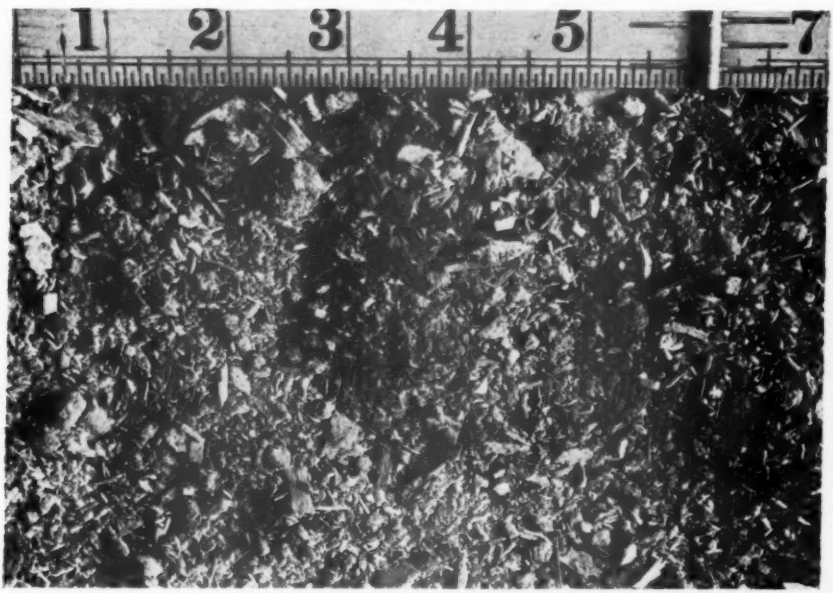


Thomas-Photos

Pen 3. Shavings over fine, dry sand



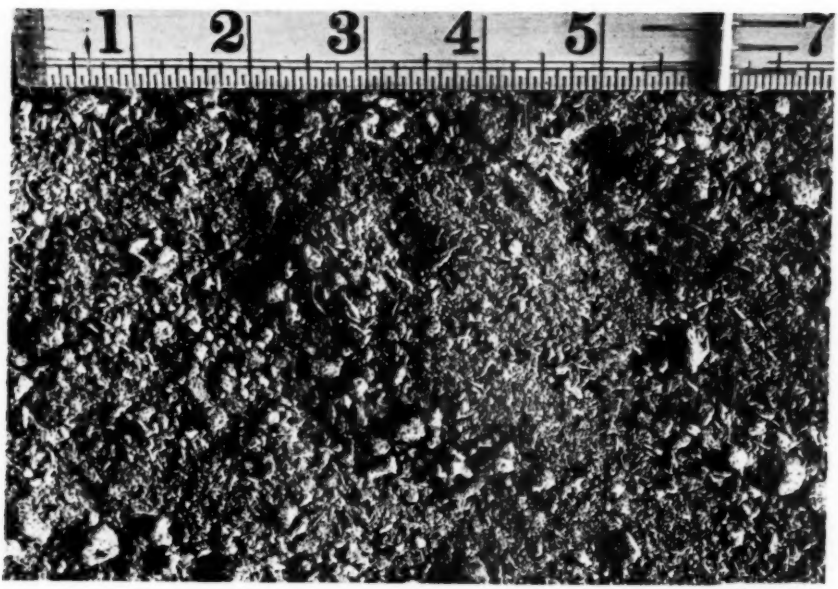
Pen 4. Shavings over hydrated lime



Thomas-Photos

Pen 5. Shavings over finely ground oyster shell

Pen 6. Chopped straw over finely ground oyster shell



Thomas-Photos

Pen 7. Peat moss and sawdust

PEN 1. SAWDUST AND SHAVINGS

The early development of this litter was very good. The chicks reared well and the litter seemed to be getting very friable. After a few weeks, however, the litter began to get increasingly dusty, and eventually, the dust became so marked as to be irritating to the birds. Under normal conditions, sprinkling with water would seem to be the obvious solution to this trouble. It appeared, however, that the problem cannot be solved so easily for, although extremely dusty, the litter began to bind in the later stages, clogging in large lumps that threatened to become soggy with increasing age.

PEN 2. CHOPPED STRAW AND SHAVINGS

This litter appeared to be the best. It was friable throughout without dustiness or matting, and seemed remarkably absorbent. Towards the end of the period some heating was noticable and there seemed to be every indication that the dry, friable nature of this litter would persist.

PEN 3. SHAVINGS OVER FINE, DRY SAND

The early stages of this litter were very promising. Later it began to clog in lumps and its friability deteriorated. It appears that the sand fails to absorb the increasing amount of excreta voided by the birds as they grow as effectively as does vegetable matter.

PEN 4. SHAVINGS OVER HYDRATED LIME

Contrary to general belief, the initial liming of the pen did not improve it. Rearing was poorer in this pen than in the others, and some chick losses were attributed to irritation from the lime. The litter did not hold together in a friable mass, and easily formed discrete heaps with bare floor patches between.

PEN 5. SHAVINGS OVER FINELY GROUND OYSTER SHELL

The development of this litter was similar to that in Pen 4. Rearing was equally poor; the birds did not seem to thrive.

PEN 6. CHOPPED STRAW OVER FINELY GROUND OYSTER SHELL

This pen was regarded as second best. It developed without dustiness or clogging and appeared to absorb the droppings very well. The chicks reared well and looked promising, although this is not reflected in the mortality figures since, towards the end of the period, an outbreak of coccidiosis caused a number of deaths. It is surprising that generally the litter with chopped straw developed better than litter with wood shavings, in spite of the success obtained with the latter in the U.S.A. The combination of the two materials seemed to be ideal.

PEN 7. PEAT MOSS AND SAWDUST

The development of this litter was slow. Whereas the material in most pens was well broken down at the end of eight weeks, the litter in this pen took a great deal longer and was rather dusty. There was a marked tendency to matting into lumps which were difficult to break up with ordinary raking.

Parasites and Mortality In addition to these observations on the development of the litter, samples were taken from the front and back of each pen and examined for parasites fourteen weeks after the start of the experiment. At the same time, two birds, selected at random from each pen, were submitted for post-mortem examination for worms and coccidia. Three pens—Nos. 5, 6 and 7— showed oocysts. The sample from the front of Pen 5 (shavings over ground oyster shell) showed 100 unsporulated oocysts per gramme; that from the back of Pen 6 (chopped straw over ground oyster shell) had 200 sporulated oocysts per gramme, and

the sample from the front of Pen 7 (peat moss and sawdust) contained 100 sporulated oocysts per gramme.

Two of the fourteen birds examined post-mortem were found to contain parasites; one of the two birds from Pen 6 showed numerous oocysts in the intestine and a few in the caeca. One bird from Pen 1 showed a few capillaria worms.

The mortality figures for the seven pens were as follows:

Pen	Percentage Mortality
1	7.4
2	1.7
3	6.5
4	7.1
5	8.3
6	9.6
7	8.0

With the exception of the low figure for Pen 2 and the high figure for Pen 6 (which has already been commented upon), no significant differences in the number of deaths were noted. All the chicks that died during the experiment were subjected to a post-mortem, but, apart from the fact that several deaths of young chicks in Pen 1 were attributed to congestion of the lungs, possibly caused by the extreme dustiness, the examination did not reveal any ailment calling for special comment, or which could be attributed to the nature of the litter.

Subsequent Observations and Costs At the end of the experiment the litter was heaped in the middle of each pen and left for a few weeks. The litter in Pen 1 heated up rapidly and cooled equally quickly, with the litter breaking down much better than would have been expected from previous observation. That in Pen 2 heated and cooled more slowly and tended to form clods, which again was contrary to expectation. The litter in Pen 3 broke down into a fine, friable mass and became rather dusty. The litters in Pens 4 and 5 became increasingly dusty during this period, while Pen 6 litter developed into a friable mass with little dust. In Pen 7, the litter developed a curious skin-like covering, although retaining its dusty and lumpy nature within.

Costs of obtaining and, if necessary, of processing (e.g., chopping) the several litters were recorded. This information is of limited value, inasmuch as the charges for the materials used will vary from one locality to another. Costs to the farmer will also depend on whether or not he has straw, sand, etc., available on the farm. The following costing (on a pen basis) of the several litter types does, however, give a rough guide on the relative charge to the farmer.

Pen	*s.*	*d.*
1	8	0
2	9	0
3	16	0
4	12	0
5	15	0
6	15	0
7	12	6

Chopped Straw gave the Best Results Summing up the experiment, it seems clear that chopped straw is of more use in forming first-class deep litter under British conditions than had hitherto been believed. Wood shavings did not repeat the success that has accom-

panied their use in the U.S.A.; possibly because of the more humid conditions prevailing on this side of the Atlantic. The combination of the two materials resulted in the most successful litter. Hydrated lime had no improving effect, but calcium carbonate (finely ground oyster shell) was fairly useful when used with chopped straw, but not with shavings. Sand was excellent in the early stages, but was not absorbent enough to fulfil its early promise: clearly, it has marked advantages if used for rearing up to about eight weeks. Peat moss appeared to be unsuitable because of clogging, and the same criticism applied to sawdust.

The writers wish to thank Dr. C. Horton-Smith of the Animal Health Trust, who carried out the parasite counts.

SOME EFFECTS OF FARM MECHANIZATION

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A study of men and machines in central Hampshire suggests that only in a few areas and on large farm enterprises can the machine be held completely responsible for displacing regular men.

THE rapid increase in the mechanization of agriculture since World War I, and especially during the past twelve years, makes British farms today the most highly mechanized in the world. Such a marked change must be expected to influence the numbers and type of workers employed in agriculture and, in addition to affecting costs of farm production, there may be important social consequences. The regular agricultural population of England and Wales (that is, farmers, workers and their families) forms, on average, about 30–40 per cent of the people living in villages, hamlets and the surrounding countryside. Any marked change, therefore, in the employment of agricultural workers will influence population numbers and forecasts in rural areas, and so affect plans for providing houses, schools and physical services such as piped water and grid electricity. This is particularly true if the demand for farm workers shifts from one area to another as a result of the ease with which certain types of farms can use machines. At the same time, increased mechanization has undoubtedly brought about a pronounced change in the character of farm work and it has improved working conditions considerably. It is increasingly important, therefore, that living conditions for farm workers should be kept in line with these improvements in working conditions.

Mechanization in England and Wales proceeded most rapidly during the years 1939–50. Yet, during that time, the total number of farm workers rose by one-sixth. For each 100 persons employed in June 1939, there were 121 in June 1950. As between regular and casual workers, numbers of the former fell during the war years but climbed steadily afterwards to a peak in 1949 which was 12 per cent above the 1939 level. Information for the years since 1949 suggests that the post-war increase in regular farm workers has

now been definitely halted, although it must be remembered that the rate of increase in the net output of agriculture has also slowed down during the past three years. The number of casual workers employed has increased substantially since 1939, though the total varies from year to year and within each year. Casual workers also make up a larger proportion of the farm labour force than they did—about 20 per cent as compared with 15 per cent or less before the war. Since 1949 the total casual force in midsummer has been about 160,000, of which about two-thirds are males.

Little is generally known as to how far mechanization has affected the distribution of labour amongst the different sizes and types of farms. A recent survey of farming changes in central Hampshire, designed to assess the effects of mechanization on farm labour needs and hence its likely effect on the farm cottage situation is therefore of no small interest. This chalk area was chosen since it had several advantages for a study of this kind. It was possible to select a compact area with relatively small variations in climate and soil, yet embracing a very wide range of farm sizes. The predominant systems of farming are, moreover, based on a high proportion of tillage. This favours the use of machines, particularly as many of the farmers between Basingstoke and Winchester are well known for their progressive outlook and ability to introduce new machines and techniques. The effects of mechanization on the demand for farm workers, together with any differences in trends according to the size of farms, might therefore be expected to show more clearly in such an area than in the more typical mixed farming regions in other parts of Britain where the average size of holding is much smaller and the introduction of farm machinery is likely to be slower.

Central Hampshire is a region of open, rolling countryside unbroken by surface streams or hedges. It is characterized by large farms on the chalk, with the villages and smaller farms lying in river valleys on the narrow deposits of alluvium. Uniform records for the years 1940–50 were obtained for a sample of 143 farms of 25 acres and above. It was thought that below this size, only specialized holdings would justify ownership of a tractor and a reasonable range of implements, or employ a regular workman other than the farmer. In this area of very similar climate, soil and topography the pattern of farming varies considerably, but seems to be determined largely by the size of the holding. Farm units can therefore be broadly grouped as follows :

Size of Holding	Type of Farming
1. Less than 100 acres	Mixed farming with emphasis on dairying.
2. 100–250 acres	Mainly corn and dairying with some sheep on the larger farms. Dairying falling in importance as size of farm increases.
3. 250–600 acres	
4. 600 acres or over	Arable with subsidiary cattle and sheep enterprises.

In these four categories of farms there were important changes between 1940 and 1950 in production, type of mechanization, and the use of regular and casual labour.

Changes in Farming Pattern There was a marked gain in the area under tillage crops on farms in each of the size groups, and a big increase in the proportion of each farm under temporary grass until 1946. Since then it has remained fairly constant. It is clear that in recent years it is only on the farms below 100 acres that acreages of arable crops have stayed above the peak war level of 1944. Wheat and barley have gained at the expense of oats on all farms during the ten-year period and there has been a decided increase in the proportion of mixed corn grown, especially

on the smaller holdings. The area under fodder crops showed no significant change; a post-war drop in the acreage of roots was offset by increased use of rape and kale, and recently, fodder beet has come into the area. The potato acreage has varied considerably, though a definite fall is evident after 1948. The practice of bare fallowing has declined.

Side by side with the marked increase in tillage there has been an increase on farms below 100 acres in the number of livestock carried per 100 acres of crops and grass. The types of livestock have also changed. The proportions of cattle and poultry have increased. There are fewer horses, sheep and pigs, although the pig population is now recovering. The fall in the number of sheep on the larger farms over 250 acres has been accompanied by an increase in store and fat cattle rather than in dairy stock. Generally, there has been a marked increase in efficiency in the use of land by livestock since 1940, and by 1950 all size-groups of farms had an average of about one livestock unit per 1¾ acres of permanent and temporary grass. It would be idle to think that the above rate of stocking cannot be still further improved, but nevertheless it lies well within the standard set by the Hampshire C.A.E.C. in 1951—that is, that not more than 2 acres of grass for grazing, hay and silage should be allocated for each dairy cow or its equivalent.

In general, changes in the distribution of crops and livestock in central Hampshire indicated a marked rise in the intensity of farming in all groups between 1940 and 1950, and the level of production at the latter date was certainly as high as the peak war-time effort in 1944. The relative gain appeared to be greatest on the farms below 100 acres.

Farm Machinery Although there has been a large increase in all types of farm machines except horse-drawn implements and horse transport, there are considerable differences in the character of mechanization according to the size of the holding. Thus:

Farms between 25 *and* 100 *acres.* Despite continued substitution of mechanized power for horse power, one-quarter of these farms were still without tractors in 1950. There are more cultivation implements, particularly ploughs, corn drills and fertilizer distributers, but the most marked increases have been in milking machines and sterilizing plant. Less than half of the dairy herds with five cows or more were milked by machine.

On farms between 100 *and* 250 *acres*, the number of tractors increased from one per 200 acres of crops and grass in 1940 to one per 80 acres by 1950. The range of implements now on these farms is similar to that on the holdings below 100 acres, though a far greater proportion of them are more adequately equipped. Very few possess any expensive machines, such as combines and pick-up balers, or machinery for harvesting sugar beet and potatoes. As with the smaller farms, there has been a marked rise in milking machines and sterilizing plants. All the farms carrying herds of more than fifteen dairy cows now milk by machine.

On farms between 250 *and* 600 *acres*, the replacement of horses and horse-drawn equipment by mechanized implements has gone so far that the only horse-drawn implements now of any importance on these farms are the ridging plough and the hoe. Although most of the farms carried a wide range of implements in 1944, important changes have taken place since that date. The most outstanding is the rise in the number of combine harvesters and balers, the increased use of disc-harrows, three- and four-furrow ploughs and potato spinners, and the greater number of lorries and vans. In contrast to farms of above 600 acres, however, the greater use of combines has not yet

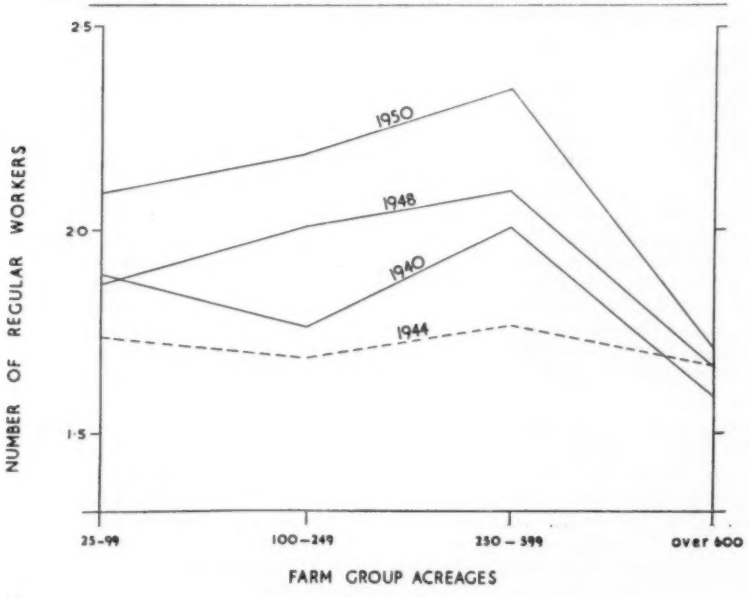
been followed by an increase in the number of grain driers.

Farms of 600 *acres and over.* The substitution of mechanical power for horse power on these farms is now almost complete. It has been accompanied by a considerable gain in draught power, partly because of the greater proportion of track layers now used. Other important features are the increase in combined harvesters and grain driers. Over 90 per cent of the holdings had one or more combines in 1950, and 70 per cent had grain driers. There has been a sharp rise in the number of pick-up balers. With cultivating implements, even the ridging ploughs and hoes have been changed to tractor-drawn types. The number of lorries and vans doubled in the ten years, and the big rise in barn machinery shows a strong move away from petrol engines to electric motors.

Effect on Farm Labour The increases in machinery available on farms in central Hampshire might have been expected to result in a decrease in the regular labour force, even though productivity has increased. This has not occurred. On the contrary, the average density of regular workers, per 100 acres of crops and grass, shows a definite increase on all farms of under 600 acres, and even on the largest farms there has been no tendency for the number of workers to fall. It appears that the results of mechanization in all groups of farms have been to increase the output of the regular labour force by: (1) improving the standard of cultivations and achieving greater "timeliness" in farming operations; (2) reducing the need for outside help from contractors and other farmers; and (3) reducing the need for casual workers during the seasonal peaks of labour requirements.

The rise in the number of regular workers, shown in the graph below, affects all but the largest farms. On the smaller farms under 250 acres, the

Number of Regular Workers (Males and Females) per 100 acres Crops and Grass



regular labour has been made more effective with the help of machines, particularly by improved working conditions for the workers, and by more thorough and timely cultivations of the tillage land. These farmers have also become less dependent on outside assistance from contractors or other farmers. The farms between 250 and 600 acres have the highest number of workers per 100 acres crops and grass, while the farms above 600 acres have the lowest. These big farms have relatively fewer livestock and less dairy cattle and, although this accounts for some of the differences in labour needs, there are also economies in manpower on the cropping side on the largest farms because of the complete mechanization of all work on the arable land. It can be seen from previous comments on farm machinery that the trend in the mechanization of farms between 250 and 600 acres is along the lines already followed by the farms over 600 acres. If this continues, the labour need of the medium-sized farms in the future is likely to fall.

The general conclusion of this survey was that there seemed little likelihood of any marked increase in the demand for agricultural workers in central Hampshire, at least in the immediate future, and therefore no need for a substantial increase in the building of farm cottages for *new* men. This conclusion was strengthened by the following additional reasons:

1. The average level of production in 1950 compared favourably with the peak war-time effort, and there do not appear to be any easy or rapid methods of improving on it, at least to an extent likely to increase the number of workers.
2. Unsatisfactory buildings and inadequate water supplies were found to be a hindrance to increased production on more than one-quarter of the holdings. Improvements to these are often costly and lengthy.
3. There is some evidence that most of the substantial improvements to permanent equipment are being carried out on the larger farms. All factors point to these holdings being the most capable of achieving increased production without the need for extra manpower.

Even if there is no support for the argument that a substantial increase in the regular labour force in the future will be needed, this does not mean that *no* new cottages are required. A comparison of the number of regular farm workers in relation to farm cottages available on individual farms showed up a number of cases where cottages are still required. A survey of the condition of existing farm cottages showed also that the structural condition of more than one-quarter was fair to bad, while one-fifth had no piped water supply. In addition, certain of the cottages are sited very badly in relation to work and public transport. These individual cases are being examined in the region so that local housing authorities can plan their rural housing schemes in relation to the agricultural need of each part of the area.

* * *

A re-distribution of the demand for labour on British farms seems to be occurring because the many rigidities found on small mixed farms on rolling land prevent the easy replacement of men by machines. Large farm enterprises with a high proportion of tillage crops seem, in practice, to be better able to adjust their labour needs to the effective use of new and better machines and, in these areas, increased agricultural production appears likely with the same, or with even fewer, regular workers.

In essence, over large parts of Britain on the more typical mixed small farms, an important opportunity for increased productivity seems to lie in the combination of existing men with new and better machines. It is only in a few special areas and on certain types of farms that the machine can be held completely responsible for displacing regular men.

FARM BUILDINGS AT THE GRASSLAND RESEARCH INSTITUTE

N. E. B. ELGAR, F.L.A.S.

Not least of interest to visitors at the new Grassland Research Institute at Hurley, Berks, will be the modern specially designed buildings for the stock.

IN 1948 the Ministry of Agriculture acquired a 500-acre block of land at Hurley, on the escarpment just south of the Thames near Marlow. The purpose of the purchase was partly to extend and partly to replace the Grassland Research Station, which, since 1940 has been located at Drayton, near Stratford-on-Avon. The programme of research planned for the new station involves, amongst other things, the maintainance of a considerable head of livestock and, in particular, of colour-marked Hereford bullocks. The need for economy and a knowledge of the life history of every animal also means that the stock must be bought as young as possible, and calf rearing will therefore form an essential feature of the stock management.

The Ministry's architects, whose job it was to design the buildings in accordance with the general layout conceived by the Management Committee of the Research Institute, had to comply with the following requirements:

1. The buildings had to be multi-purpose, so that new methods of research involving a change of practice, as, for instance, a switch-over partial or complete, from the bullock to the dairy cow as a means of measuring productivity, could be undertaken without undue expense or elaborate adaptations.

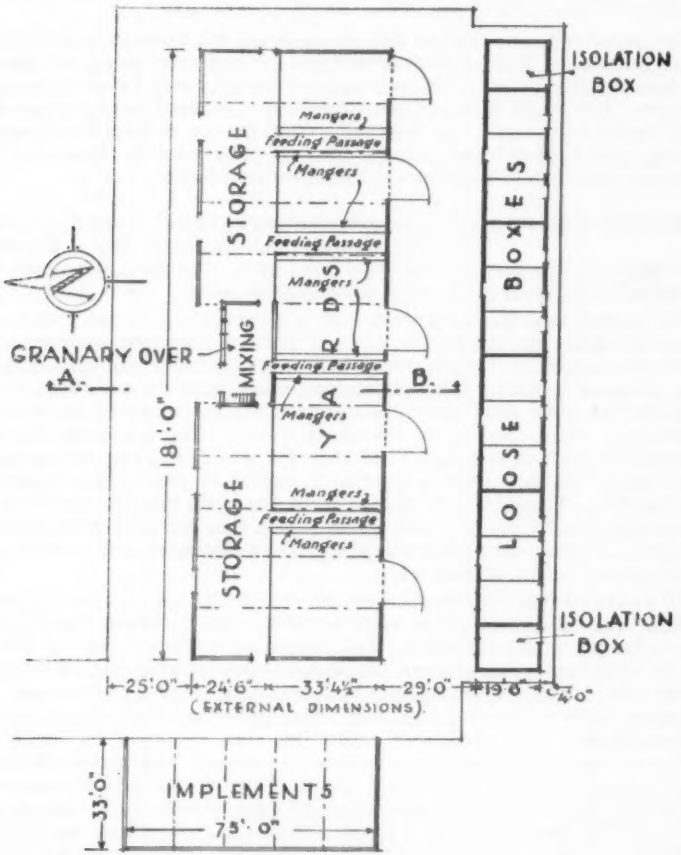
2. They had to be functionally sound: that is, they had to suit the requirements of both practical husbandry and research or investigational work.

3. They had to be both permanent and reasonably inexpensive.

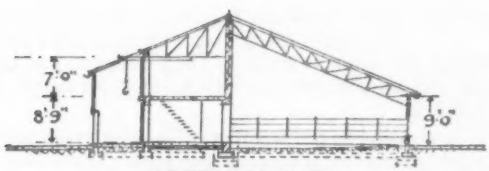
The architects started with one great advantage—a bare site on level ground with good drainage. They were thus spared the unsatisfactory compromises which normally have to be made when existing buildings have to be incorporated into new schemes.

The Layout of the Buildings The buildings at Hurley consist of two parallel ranges separated by a concrete road 25 feet wide, with the long axis of the buildings running east-west. The southern range comprises four loose boxes, each measuring 39 feet by 18 feet. Each box is divided into three equal size pens by removable tubular divisions. At each end of the range there is an isolation box measuring 13 feet by 18 feet. This range is at present used to house the calves until they are big enough to move across to the north range. It also gives temporary accommodation to the nurse cows which, at feeding times, enter the pens and are tied up and fed their concentrates whilst multiple suckling the young calves.

The northern range is likely to be of particular interest to the farmer-visitor. It is 180 feet long, with a span of 54 feet ,and consists essentially of a 12-bay barn-like structure 33 feet wide, with a 21 feet wide lean-to on the north side. The building is open to the eaves on the south side and clad to ground level on the other three sides. The barn is 9 feet high at eaves level on the south (open) side, and is, at present, subdivided into six yards to house bullocks and nurse cows, the lean-to being used for the storage of hay and straw. The yard fencing is of removable tubular sections, and incorporates



BLOCK PLAN. SCALE 10 0 50 FEET.



SECTION A.B.

SCALE 10 0 10 20 30 FEET

built-in hay-racks and mangers. There are three transverse feeding passages running across the building and, in addition, each yard has mangers and hay-racks along the north side. All the internal fittings are removable, and in consequence the whole layout of the yard is most flexible.

The lean-to, which is 16 feet high at the eaves, incorporates a two-storey granary 15 feet by 30 feet in the centre bays. The two remaining portions of the lean-to, though primarily intended for storage, may be used for any purpose. It is clear, however, that their use as covered storage space for baled hay and straw and as a dumping ground for two or three days' supply of silage greatly eases littering and foddering. The centrally placed granary ensures a minimum of walking when feeding concentrates.

Constructional Features An interesting feature is the use of slotted asbestos sheeting forming the roof over the stockyards. The whole of the floor of this large building is concreted, the stockyard portions being dished to 12 inches below ground level.

The general structure is of steel, the ridge being carried on 10-inch by 5-inch H-section stanchions, and the wall plate on the south side on 8-inch by 4-inch stanchions. The northern half of the roof (the lean-to) is carried by a series of cantilever trusses which stand out from the main stanchions and need no other supports. The southern half of the roof is carried on lattice-type girders instead of the usual trusses. The advantage of this method of construction is that the total roofed area of 9,720 sq. feet has only one line of eleven interior supports—a matter of great importance for adaptability. The gable ends and the north side of the building are of 9-inch brickwork to a height of 6 feet, above which they are clad with asbestos sheeting. The two-storeyed granary is of 9-inch brickwork with a reinforced concrete floor to the upper storey.

To what extent has the original conception fulfilled the necessary requirements? Has adaptability been exploited to the full? Do the buildings really justify the use of the description "multi-purpose"? A full examination of all the other layouts considered, probable or even possible, leads inevitably to the conclusion that this block of buildings forms the nearest approach to complete adaptability that has so far been produced. Modifications and minor alterations are needed, of course, but this is no carping criticism. No prototype in any form of constructional work has ever become the production model without alteration. The main building could well become—subject to the minor alterations suggested later in this article—the model within which almost any layout to suit almost any type of farming could be planned. County Council smallholdings, and new farms carved out of our marginal land, could each be equipped with buildings of this type to the advantage of farmer, labourer and stock.

Possible Improvements The functional soundness of the conception is, on the whole, admirable, and both stock and stockmen appear to appreciate the thought given to their comfort and convenience. The modifications and improvements which seem to be called for may be summarized as follows:

1. The site is very exposed to the weather. The due south aspect has the usual disadvantage that the south-westerly winds carry rain under the eaves and into the yards(1). It would have been better, had it been possible, to turn the axis of the whole range through 45 degrees so that the buildings faced south-east instead of due south. But this would have made planning awkward because the approach road runs east-west. Some protection could

have been given, however, by continuing the roof slope a few extra feet to provide overhanging eaves—a treatment similar, in fact, to that accorded to the range of boxes across the road.

2. The arrangements for feeding might be improved by making alterations to allow a tractor and trailer to pass down a feeding passage running the full length of the building. At the moment, feed has to be carried by hand from dumps left by trailers at several points at the ends of the transverse feeding passages. This wastes both time and energy, particularly when heavy foods such as silage are being used—and anything up to 3 tons has to be fed each day! This would involve an alteration in the width of four doorways, one in each gable end and one in each end wall of the granary. It would also entail a passage being left between the stores of baled hay and straw on the one side and the mangers on the other.

The total yard area is 5,940 sq. feet, and if 80 sq. feet is allowed as sufficient for an 11-cwt. bullock, the stock-carrying capacity is 74 head. A high proportion of younger cattle would naturally increase the total capacity of the yards to a maximum of, say, 100 head. The total manger space amounts to 246 running feet, that is, 3 feet 4 inches per 11-cwt. bullock. But this is unguarded, so there is nothing to prevent a greedy animal walking sideways down the full length of the manger, if it is so minded, thus depriving its weaker companions of their proper share.

Experience in the yard feeding of dairy cattle shows that 2 feet 4 inches is sufficient manger space, provided the manger is guarded by automatic or manually-operated yokes(2). Thus a guarded manger running the full 180 feet of the building would feed 77 dairy cows in comfort. The writer is not aware of any essential differences in manger needs between the cow and the bullock, and it seems as though the transverse passages could be eliminated altogether provided the number of bullocks did not exceed 77. If this number is exceeded, one transverse passage—with a manger on each side—would probably be sufficient, instead of three as at present. This alteration would undoubtedly make feeding a much less laborious operation.

3. The water-troughs with which the yards are equipped are rather dangerous for young animals, and no provision is made for raising them as the height of dung increases. Water-bowls fitted with flexible connections would be cheaper, simpler and could be raised or lowered at will.

4. The use of slotted asbestos sheeting undoubtedly aids ventilation but it precludes the use of the building for any purpose where absolute water-tightness is necessary, since under certain conditions of wind and rain, sheeting of this type allows appreciable quantities of water to pass. The building could not, for instance, be used for the long-period storage of grain.

Criticisms of the range of loose boxes are confined to matters of detail. It is suggested that a pen measuring 18 feet by 13 feet is extravagant to house no more than four calves, and that the sub-division of the box into four instead of three would make better use of the available space, thus providing pens measuring about 18 feet by 10 feet. There would still be ample room for the nurse cow at suckling times. The use of a fixed manger seems to be a mistake as it takes up valuable floor space and provides two dangerous corners. The use of a loose feeding pen on the floor with a peg outside on which it could be hung when not in use, would be a more practical arrangement. The water-bowls in this range of boxes are not adjustable for height—a most important point when the age of stock being housed is so variable. As to the permanence of these buildings, the materials and the method of construction are such as to justify the hope of long life at low maintenance costs.

FARM BUILDINGS AT THE GRASSLAND RESEARCH INSTITUTE

The Grassland Research Institute may well congratulate itself on having at its disposal a range of up-to-date buildings which will facilitate its work, instead of the more usual makeshift adaptations with which most of our research stations seem to be equipped. The whole layout should certainly be inspected by anyone faced with a problem of rebuilding—whatever his farming plan may be, whether or not he is interested in the work of the Research Institute, whether stock-keeper or arable farmer.

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HIGH PROTEIN FEEDING BARLEY

H. HUNTER, M.A., D.Sc.

Although about 25 per cent of the barley produced in this country is used for animal feeding, little is grown specifically for this purpose and, accordingly, the protein content is often not as high as it should be for feeding to livestock. Consideration might be given, says the writer, to increasing the protein by a late dressing with nitrogen.

AN evaluation of barley as an animal feedingstuff has been made by a leading nutritionist as follows (1) : " Barley is somewhat similar to wheat in composition, and contains on an average 8.6 per cent of protein, 1.5 per cent of oil, 68 per cent of carbohydrate, 4.5 per cent of fibre, and 2.6 per cent of ash. Owing to its higher fibre content, it is more palatable than wheat and does not develop pastiness during mastication. It is one of the most popular foods for pigs, but it should be remembered in this connection that barley meal is deficient in protein and ash. For all but the full-grown fattening pig, barley meal must be fed in conjunction with foods supplying liberal amounts of protein and ash."

The quantity of barley produced annually in the British Isles exceeds the requirements of the brewing and distilling industries, and after providing seed for the succeeding season there is normally a substantial quantity for use as animal feedingstuffs. According to the 1925 Agricultural Census of Production (2), the quantity available for seed and feeding was 35 per cent of the whole crop ; thus, allowing 10 per cent for seed, the balance for feeding was 25 per cent of the total production.

Barley used for feeding is not generally grown specifically for this purpose but is, in fact, grain which has failed to reach the malting standard of the season. Apart from incidental conditions, such as excessive quantities of weed seeds and faulty screening, the reasons for its rejection are that it is small and thin, often as the result of unfavourable weather, or that it contains too high a proportion of protein, arising again from indifferent weather or from too high soil fertility. Although unsuitable for the highly competitive barley market, grain of this description finds a commercial outlet as feeding material, always provided that its "condition" is satisfactory.

Since the price offered for barley of feeding quality is lower than that obtainable for grain of malting quality, the only means of securing a monetary return for feeding grain commensurate with that of malting barley is by a higher yield of grain per acre. Because feeding barley produced in this country is derived from malting varieties of high grain-yielding potentiality, the higher yields needed to adjust the monetary values of the two classes of grain can hardly be expected, and in practice the final result represents an escape from what is virtually a partial crop failure, or at least, a departure from the grower's hope and intention.

Provided the "condition" of the grain is satisfactory, the actual feeding value of barley used for this purpose, compared with that of malting barley, may be slightly enhanced. Thus the grain of a lodged crop is frequently more nitrogenous than that of a crop that remains erect until it is harvested ; to this extent the grain, although unsuitable for malting, is more valuable as feeding material. On the other hand, since the husk of barley, under all conditions, is much less nitrogenous than the true grain, a thin, husky barley may contain less protein than one in which the grain is decidedly better filled. An example of this condition is provided by some of the very coarse Abyssinian varieties, in which the husk is readily detached from the grain proper, thereby enabling the protein content of the hulled and of the naked grain to be determined separately without difficulty. In a sample examined recently, the protein content of the hulled grain (that is, grain with enveloping husk) was 10.6 per cent, whereas in the naked or dehusked grain it was 11.9 per cent.

But whether barleys are diverted to feeding because they are too high in protein or because they are too coarse and husky for malting, they remain essentially carbohydrate in composition, and Woodman's qualification of their feeding value, particularly when fed to young animals, is significant.

The Protein Content Taken over a succession of years, the protein content of malting grain of all varieties in common use in the British Isles is approximately 9–10 per cent, although this figure may be less in very favourable seasons and under specially favoured conditions, or rise to about 12 per cent in unfavourable seasons ; the latter amount, however, is in excess of what is generally regarded as reasonable for malting grain.

Even at the relatively high figure of 12 per cent of protein, barley falls far short of a product such as field beans, which contain 25 per cent or more than double the amount of this constituent. It might be argued, therefore, that at the present time, when protein is urgently required for animal feeding, field beans should form the basis of animal feedingstuffs supply—at first sight a very legitimate contention. Against this, there is the incontestable fact that barley is a much more reliable crop on all but the very heaviest soils—a factor of considerable agricultural and national importance.

As the varieties from which supplies of home-grown feeding barley are at present derived have been bred to meet malting and brewing requirements, and are in consequence designedly low in protein, two questions arise. First, is it possible to reverse the direction of plant breeding and to develop high protein varieties specifically for animal feeding ; and, secondly, can the crop be manured in such a way as to obtain a substantial increase in protein content ?

It will be observed that the first line of inquiry involves the production of barleys of an entirely different genetic constitution to those now in use, while the second amounts to nothing more than an induced condition relative to individual crops only, and does not provide a permanent solution to the problem. Nevertheless, if a system of manuring can be devised that will bring about a higher protein content it will be applicable to new true feeding varieties of the type visualized above, as well as to existing varieties. But since high grain yield is fundamental in all types, whether new or old, a high degree of resistance to lodging must never be overlooked.

The very large number of comparative trials of varieties of barley conducted in the British Isles in the last fifty years indicate that the difference in protein content between those which may be described as good malting varieties, and those of inferior quality is actually very small. In the Irish experiments, for example, the difference between Old Irish, which was one of the poorest varieties, and Archer which, prior to the advent of Spratt Archer, exemplified very high malting quality, was less than 1 per cent of protein; it may be noted also that the grain yield of Old Irish was inferior to that of Archer by 13 per cent.

Even when the search for high protein varieties is extended more widely, the field of possibilities is invariably limited by considerations mentioned above, and it is always questionable whether the higher figures exhibited by the few examples that have come under review are rightly attributed to a different genetic constitution, or are rather an expression of the environment in which the particular samples in question were grown. An example of this is provided by Trebi, a six-row barley which earned prominence in the United States and in Canada recently by reason of its relatively high protein content when grown in those countries. Yet, when Kenia, which has been shown to possess only a slightly higher protein content than malting varieties like Spratt Archer and Plumage Archer, and Trebi were compared at Cambridge in 1951, they gave practically an identical protein content.

Thus it appears that in the development of varieties of true feeding barley the plant breeder has little hope of obtaining genetically high protein breeding material from either home or foreign sources. Moreover, high grain yield is axiomatic in true feeding barleys since, except on soils on which for various reasons it is impossible to produce grain of malting quality, the competition they will meet will be from true malting barleys; and in this country these are high grain-yielding forms. Indeed, in reviewing the development of malting barleys in recent years, there is good reason for concluding that low protein and high grain yield are associated characters, and there may thus be a biological obstacle to the combination of high protein and high grain yield. Camton, a coarse grain barley produced at Cambridge as a feeding sort, is an apposite example of this condition, for it is distinctly prolific and although a little richer in protein than malting varieties grown under identical conditions, it does on occasions reach a malting standard. Thus, while Camton exemplifies the high grain-yielding feature demanded in true feeding varieties, it fails to produce the qualitative characteristics originally hoped for.

Nitrogenous Fertilizers to Increase Protein A further interesting feature of Camton is its highly lodging-resistant straw, and this attribute, in combination with high grain yield, brings the variety within the purview of the second means of obtaining high protein barleys, namely, by the use of quickly acting nitrogenous fertilizers.

HIGH PROTEIN FEEDING BARLEY

It is well known that nitrogenous fertilizers applied at or about sowing time, particularly when accompanied by adequate supplies of phosphate and potash, enhance the yield of barley grain very significantly, and that used under these conditions they do not necessarily involve a high protein content and hence inferior malting quality ; indeed the reverse is often the case. This was demonstrated in a series of manurial trials carried out at Cambridge (3) with Spratt Archer in 1936 and 1937, with Spratt in 1937, and with Kenia in 1945. From plots which received nitrate of soda at the rate of 1 cwt. per acre *at the time of sowing*, compared with controls which received no nitrogenous fertilizer, the percentage of protein in the grain, and the relative yields of grain were as follows :

Year	Variety	Percentage of Protein		Grain Yield
		Control (no fertilizer)	1 cwt. Nitrate of Soda	(Control=100)
1936	Spratt Archer	9.4	9.1	143
1937	Spratt Archer	10.4	10.0	150
1937	Spratt	10.9	10.1	146
1945	Kenia	10.6	10.8	114

Entirely different results were obtained when a quickly acting fertilizer, again nitrate of soda, was applied to the crop when *the ear was emerging from the enveloping leaf sheath.* At this stage the increase in yield was much smaller, practically no additional tillers were formed, and the increase in the length and volume of straw was negligible. As shown below, nitrogen applied at this more advanced stage in plant development instead of being utilized in a vegetative direction promoted an increased quantity of protein in the grain :

Year	Variety	Percentage of Protein		Grain Yield
		Control (no fertilizer)	1 cwt. Nitrate of Soda	(Control=100)
1936	Spratt Archer	9.4	11.4	109
1937	Spratt Archer	10.4	12.7	106
1937	Spratt	10.9	12.8	105
1945	Kenia	10.6	12.3	99

The question that now arises is, if we take advantage of the greatly enhanced yield which follows an early application of nitrate of soda, what will be the effect of a second application made at a very advanced stage, *such as three weeks after flowering, or approximately three weeks before full ripeness* ? A trial on these lines was made with Spratt Archer and Spratt in 1937 with the following result ; in this case, however, the comparison is made between the single and the double application of nitrate of soda :

Year	Variety	Percentage of Protein		Grain Yield
		Single Application	Double Application	(Single Application=100)
1937	Spratt Archer	10.0	12.0	103
1937	Spratt	10.1	12.3	110

It will be seen from these results that the differences in protein content brought about by the nitrate of soda, although small, are at least double the difference that exists between good and inferior malting barleys. Moreover, by late applications of quickly acting nitrogenous fertilizers such as the one used in this investigation, it is possible to secure the combination of the enhanced yield proceeding from a normally early application and a higher protein content, without undue risk of the crop lodging.

It will be further noted that the quantity of fertilizer used in these investigations was not a large one, and as the risk of the crop lodging at the very advanced stages employed in the trials is small, it is probable that larger quantities could be used to promote still larger increase in protein content.

In these experiments the optimum results in the direction of protein content were obtained when the fertilizer was applied at an advanced stage of crop development, and in farming practice a procedure of this nature presents obvious physical difficulties. It is clear that the ordinary fertilizer drill could not be operated without damaging the crop (perhaps seriously if at any time the straw was well grown), nor could the fertilizer be applied by hand very easily. Fortunately, other means of distribution are being considered, and there is a likelihood that the helicopter may be found as useful in this connection as it has been in other agricultural operations. Again, since the essence of the proposition is the application at definite stages in plant development, another solution of the problem may be found in the use of fertilizers with delayed action which could be applied at or about the time of sowing.

(*Dr. Hunter's recent book, "The Barley Crop," is reviewed on page 545—Editor.*

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FARMING AFFAIRS

De-Control of Cereals and Feedingstuffs

The White Paper on the De-control of Cereals and Feedingstuffs holds out more opportunities to all engaged in British agriculture than any action of the Government since the passing of the Agriculture Act and the launching of the Expansion Programme in 1947. The changes announced in the White Paper that specifically affect agriculture are as follows :

1. All rationing of feedingstuffs ends from next harvest. The precise date when this becomes effective will be announced later.

2. The controls on the prices of cereals will also be removed as from next harvest.

3. The present subsidy on feedingstuffs will be withdrawn on April 1, 1953.

4. The rate of imports after de-control will be adequate to maintain the present supply of feedingstuffs ; and during the first year after the end of feedingstuffs rationing, the Government will be prepared, in the event of any critical shortage of supplies leading to a serious upward trend in prices, to consider authorizing such additional imports as may be needed to maintain a livestock population which is expanding in conformity with the White Paper programme issued after the 1952 Annual Review.

5. To implement the Government's obligations under Part I of the Agriculture Act, 1947, the Ministry of Food will remain ready to buy any supplies of cereals from the 1953 harvest offered under existing arrangements. Further,

these arrangements will continue until the new permanent arrangements for implementing the price and market guarantees under the Agriculture Act, 1947, can be settled, after full consultation with all the interests concerned, and brought into operation.

What it Means to the Farmer

Farmers will welcome the freedom to buy such feedingstuffs as they need without restrictions. Any rationing scheme must be restrictive, and for pig and poultry producers feedingstuffs rationing is particularly so, because it is so largely based on 1939 conditions. To have changed the basis would have helped a number of farmers while upsetting others. It is much better to take the straightforward step of complete de-rationing.

Paragraph 16 of the White Paper *The Annual Review and Fixing of Farm Prices*, 1952 (Cmd. 8556), stated that the Government could not contemplate any prolonged continuation of the feedingstuffs subsidy and that it would be impossible to relax the present controls until the subsidy had been removed. The Government therefore intends to discontinue the subsidy on feedingstuffs after April 1. The present trend in world prices suggests that any increase in feedingstuffs prices in this country will not be very great. If, however, a serious upward tendency in prices develops and persists under free market conditions, the question of further imports of feedingstuffs will be considered as set out in paragraph 7 of the White Paper. On the other hand, the removal of control and the abolition of State trading will result in certain economies.

The effect of any increase in feedingstuffs prices on farm costs will, of course, be one of the factors taken into account at the forthcoming Annual Review.

The best thing that livestock owners can do is to grow more coarse grains and fodder crops this year, and make a special effort to get more out of their grassland. Anyone who can grow grain should be stimulated to increase his acreage of cereals either for his own use or for sale. There is still time for farmers to decide to grow more crops for this year's harvest, and the ploughing grants already give a strong inducement to the breaking up of grassland for this purpose. Barley and oats from the next harvest may be sold without maximum prices, but the Ministry of Food will buy any supplies offered under existing arrangements.

The best time to lift those controls is at harvest. Until then, the rationing scheme will remain in force. Irksome as these restrictions are, all farmers are urged to work them with goodwill for the next few months.

Farmers will see that they have specific assurances about the method of implementing Part I of the Agriculture Act, 1947, in respect of both the 1953 and 1954 cereal harvests. There will thus be plenty of time for full discussion with the National Farmers' Unions of the United Kingdom about the form of future arrangements for guaranteeing prices and markets for these crops.

From Controls to a Freer Economy

The policy of de-control, of which these decisions are an example, naturally raises questions about the implementation of the Agriculture Act generally. The Government has been giving consideration to the ways and means of effecting an orderly transition from the rigid system of post-war controls to a freer economy, while ensuring that the arrangements for dealing with each commodity in that context maintain the stability provided by the guarantee of price and assurance of market inherent in the Agriculture Act, on which

farmers' production plans essentially depend. In accordance with this policy, the Government proposes to continue the system of price reviews with a view to ensuring realistic and economic price guarantees designed to encourage the required production as laid down in the Agriculture Act, 1947.

The Government considers that the principles of that Act and, with suitable modification, their practical application, must and can be maintained in conditions of less rigid control. The details of method may vary in relation to different commodities, but the Government proposes, in consultation with the United Kingdom National Farmers' Unions, to work out appropriate methods for dealing with each commodity.

The Government feels that in suitable cases the Marketing Acts, 1931-49, provide effective means through which the guarantee of prices and assured markets could be operated, and that through these or other appropriate measures, producers would themselves be able to make a practical contribution to the desired stability and yet safeguard the interests of consumers. In conformity with those Acts, the other interests concerned would also have to be consulted. Obviously, there are intricate financial and marketing problems to be faced in operating such arrangements in a free market. It is the hope and aim of H.M. Government to solve them, but it is essential that sufficient time be taken to find effective long-term solutions while realizing that there is an urgent need to evolve an immediate interim arrangement for eggs.

To sum up, farmers are being given a wide new measure of freedom. Their guarantees of price and market are being continued. They can now take full advantage of this new freedom to produce more food for man and beast in their own and in the nation's interest.

A Longer Grazing Season Recent research suggests strongly that many classes of farm animals can be kept at pasture for the whole twelve months of the year without feeding bag foods of any kind. If we look at our permanent pasture we find that in an average season it gives little more than a maintenance ration with good production for perhaps ten weeks during the summer. It produces little or nothing from mid-October to the following mid-May (fully seven months).

The picture is very different on farms carrying good leys. These produce milk and meat for quite twenty weeks in summer and supply maintenance for at least another 10–12 weeks. The good ley, therefore, is capable of doubling production compared with average permanent grass and, in addition, adds 50 per cent to the time spent by animals at pasture.

The question is, can we do still better with the ley and, if so, how? The answer is yes. Scores of pioneering farmers up and down the country, on all kinds of soils, are producing at much higher levels. Very simply, these men regard their grass/clover fields much as every one of us thinks of arable. Once we get into the habit of thinking of grass as a crop, it becomes easy to plan and not very difficult to practice, producing a crop of grass (or a series of crops if you like to think of it in that way) for each month of the growing season from mid-March to mid-November (a grazing season of eight months) and to produce meat and milk from grass alone pretty well for the whole of this period. You may feel that this is aiming high, but I believe it will seem mediocre to the British farmer of 1970.

Let us look at the basis for all this and start in March when in most years ryegrass comes into spring growth. If early keep is the aim, try a field of

Italian ryegrass (or the N.Z. H.1) grown on its own which will allow heavy manuring. This grass is most responsive to nitrogen at all times of the year. The fields used for early bite should be completely rested in winter, at least from mid-October onwards, and given 3 cwt. nitrogenous manure—one-third in October and the rest in February.

Italian ryegrass is a biennial, but there are a number of perennial species, including ryegrass, tall fescue, meadow fescue and cocksfoot, which, if appropriately manured in February after having been completely rested since the previous October, will produce keep very early. From mid-April to the end of June most leys will produce grass at a rate in excess of the needs of the grazing animal, so that efficiency then turns on conserving the surplus whilst still of high quality.

Between July and early September, however, we may again run into periods of shortage, particularly in the drier half of England. In the west, pastures based on cocksfoot, meadow fescue and the clovers (e.g., S.100) will cater for the driest summer, but in the east and south of England reliance is placed on lucerne mixtures which, if rested from mid-June, will produce abundant green food in a dry time after midsummer. The electric fence (using the back fence) is an essential piece of equipment when grazing the lucerne ley. Lucerne should be completely rested from mid-September to early November but requires grazing off in early winter, and so helps to extend the grazing season into November and even December.

If we choose the right varieties for our leys, manure well, and manage our grazing properly, we can provide grass for whatever period of the year we may want it.

William Davies

Farming Cameo: 27. The Rodings of Essex

The Rodings in the time of Arthur Young were world famous for their corn production and general standard of farming. There are eight of them and they consist of about a dozen parishes along either side of the River Roding about eight miles north-west of Chelmsford and are known locally as the "Roothings". It is one of the most fertile parts of Essex and covers an area of about 20,000 acres. Although only about fifteen miles from the suburbs of London, this district has remained completely rural and most of the villages are still picturesque and very little influenced by the building programme which is affecting such a lot of the farming land in the county.

The soil here is a very fertile boulder clay over chalk, lying about 250 feet above sea level. Although the district would be regarded as rather flat, it is suitable for mole draining, being of a uniform texture with sufficient slope. The hedges, where they are not completely cut down, are generally kept well trimmed.

The farms vary from 50 to 500 acres, but probably most of them fall in the 200–300 acre range. Traditionally, this land has always been farmed as arable and the only livestock used to be store cattle bought in the autumn and fattened off in yards by the spring. Nowadays there is some fattening on leys but this is not very extensive as yet. A recent development in livestock is pig keeping, which is not surprising as the district is very close to the Dunmow Flitch factory.

The main crops grown are wheat, barley, potatoes and sugar beet. The production of Essex broad red clover seed is a most important part of the rotation, the second cut being taken for seed and marketed under the Seed Inspection Scheme. Some farms have been growing the same stock of Essex red clover for as long as forty years. It is this seed cut which makes

the clover crop economic at the present time, besides providing a break from white straw crops.

The nearby Felsted sugar beet factory was opened in 1926 with an area of 4,000 acres of beet; today the acreage is 21,000. Over a number of years the Rodings have averaged about 13 tons per acre of clean beet, and even in a bad beet year they have generally come out with a crop well above the factory average. This crop helped many of the farmers to tide over the depression of the early thirties and they were able to continue arable farming when so much of the heavy clayland in Essex tumbled down to grass and was turned over to dairying. There are very few dairy herds in the district but the few that have been established are high-yielding herds kept on really good quality leys.

Much of the harvesting is done by combine. There is a slightly higher acreage of wheat than barley. Quite a number of farmers have installed their own corn storage plants and are able to hold their wheat for the higher spring prices. Most of the installations are mechanically equipped and include dressers but few have driers. There are, however, probably enough driers in the district to cope with the damp corn in bad seasons, which are less frequent in the dry Eastern counties than elsewhere.

The Rodings are still famous for corn production and, with the introduction of power farming, more rootbreaks have been possible. This has improved the rotation and given all-round increased production.

J. A. Young,
District Advisory Officer

Agricultural Scholarships The Ministry of Agriculture and Fisheries invites applications for the following scholarships :

Ten Senior Scholarships for degree or diploma courses in an agricultural subject (degree courses at University Departments of Agriculture, diploma courses at the Agricultural Colleges and the Essex and Lancashire Institutes of Agriculture) ; or for courses in Veterinary Science at Veterinary Colleges.

Six Extended Junior Scholarships (for those who have already held Junior awards), and

Sixty Junior Scholarships tenable at Farm Institutes for courses not exceeding one year in duration, in agriculture, horticulture, dairying or poultry husbandry.

The scholarships are open to the sons and daughters of agricultural workmen or of working bailiffs, smallholders and other rural workers whose means and method of livelihood are comparable with those of agricultural workmen, and to persons who are themselves *bona fide* workers in agriculture. The value of awards is assessed on a sliding scale according to the circumstances of the parent, or guardian, and the applicant, Senior awards being comparable to State Scholarships. The usual method of selection is by interview, no written examination being held, but candidates must be able to satisfy the Selection Committee that they will benefit by a course of instruction and that they intend to follow an agricultural pursuit on completion of their training. Candidates must have attained the age of 17 on September 30, 1953.

Full information about the scheme and forms of application may be obtained from the Secretary (Room 314), 1 Cambridge Terrace, Regent's Park, London, N.W.1, or from the Education Offices of County Councils.

The latest date for submitting completed applications is March 31, 1953.

BOOK REVIEWS

The Barley Crop. HERBERT HUNTER. Crosby Lockwood. 21s.

Dr. Hunter's new book refers extensively to investigations in barley growing conducted in Ireland in the first quarter of the present century. The subject-matter of an earlier book of the same title has become a classic, and in the present volume is extended to describe the results of investigations conducted in Britain and elsewhere. A comprehensive account of types of malting barley is given, with particular attention to Atterberg's system of classification, and to the amplification of identification provided by later detailed studies of the lodicules. Rachilla characters are shown with the aid of some excellent photographs; for the sake of those not possessing technical training in the subject, it might be valuable, in a later edition, to include drawings showing the relative positions of the glumes, pales, rachillae and lodicules. There is also a fine set of photographs of individual grains, but the text-book as a whole is not primarily intended to serve as an identification hand-book of modern varieties of barley but rather, as its title indicates, the more general aspects of barley production and the characteristics which determine the economic value of the crop.

Quality in malting barley is the subject of a well-balanced chapter in which classic varieties are examined critically. The relation of barley production to soil and climate is particularly valuable, and the development of varieties such as Archer, Standwell, Chevallier, Spratt Archer, Plumage Archer and Earl illustrate these principles.

Those who produce barley for seed will welcome this account, by the breeder, of the development of the two forms of Spratt Archer which characterize barley growing in Eire and Eastern England respectively, and the record of the different types of Plumage Archer. Reference is also made to critical seed selection experiments, but commercial production of high quality seed under the Field Approval Scheme, which now extends to 16,000 acres of seed crops, is not mentioned.

A review of barley varieties tested in yield trials by the National Institute of Agricultural Botany draws attention to the ephemeral reputation of many new types. On the other hand, most notable increases in production and malting quality resulted from the growing on an extended scale of varieties such as Spratt Archer and Plumage Archer and Pioneer, which first proved their worth in the Institute's trials.

The characteristics of the straw of some of the principal varieties are displayed in a very useful illustration, but the stiff-straw Scandinavian types such as Rika and Herta have not been related to earlier forms. This may be because the author does not consider that these two barleys come within the category of malting barleys.

There is a particularly valuable chapter on the acreage and yield of barley in the leading countries in which the crop is grown, and it is perhaps surprising that approximately 30 per cent of the world barley acreage is found in China and the U.S.S.R. In yield per acre, Britain comes second only to Denmark, but the differences in average yield are wide and provide food for serious thought. A very valuable map is included showing the concentration of barley growing in relation to geographical and climatic factors in England and Wales.

A useful summary is given on the manuring of the barley crop, including a digest of the long-term investigations conducted on the celebrated Hoos Field, Rothamsted. It is interesting to receive from Dr. Hunter an account of various breeding objectives with malting barley. The book has a useful summary and an equally useful index.

Apart from its obvious value to those concerned with commercial aspects of barley intended for malting, this book can be warmly recommended to students of all ages who wish to extend their knowledge of the factors which influence quality and yield of this important cereal.

F.R.H.

Farm Animals. JOHN HAMMOND. Edward Arnold. 18s.

This second edition of a book that has already become a standard reference work for stock-breeder and student, is assured of a warm welcome. Since it first appeared in 1940, considerable advances have been made in the practical application of the knowledge of animal physiology, and the present work brings us up to date as far as these techniques apply to farm animals.

The developments most likely to interest agriculturists are those concerning the transplanting of fertile ova into foster-females—work which is, apparently, no longer of merely academic interest, but approaching the stage where it may have as revolutionary an effect on practical farming as artificial insemination has had in the last ten years. But this book is by no means confined to future prospects. All the important principles of breeding, growth and inheritance are explained with commendable clarity and simplicity. Its value to the majority of readers will be, however, in its application of these principles into everyday

farming practice. The breeder of any class of livestock—whether cattle, horses, sheep, pigs or poultry—will find here a wealth of practical hints on avoiding and overcoming breeding problems. The sections devoted to increasing fertility and combating sterility contain information of value to every breeder of animals.

Dr. Hammond makes it very clear that improvement in breeding methods must go hand in hand with improvement of environment if we are to get the best out of our farm animals. The effects of a low plane of nutrition in early life are shown to be the cause of much of our uneconomic production in meat-growing animals, and information on this point, illustrated as it is by simple diagrams, tables, and photographs, is presented in just the form in which it will appeal to the average farmer. For him, the book is good value, even if he does no more than study the excellent photographs and assimilate the lessons that are there for the learning.

H.B.

Dairy Farming (2nd Edition edited by K. N. Russell). V. C. Fishwick. Crosby Lockwood. 18s.

Written in practical rather than scientific language, this second edition of *Dairy Farming*, which has been revised to include recent changes in legislation, new ideas on feeding, and the developments towards greater efficiency which have taken place since the book was first published in 1947, will undoubtedly appeal to a very wide field of readers. Eminently readable, it is a praiseworthy attempt to introduce both the theory and practice of milk production from an elementary angle, and should thus prove of value not only to the practising farmer seeking a knowledge of the underlying principles of the industry, but also to the newcomer to dairy farming and to the student.

The first part deals with the technical aspects of milk production, including feeding, breeding and clean milking. The information on feeding practice has been brought up-to-date and, as might be expected, dried grass and its uses are frequently discussed, but I should have liked to have seen further discussion on the feeding of silage, especially to younger stock, as a means of saving concentrated foods. Some description of silage-making would have fitted into the discussion on grassland.

The chapter on health and disease is written in a most practical way and gives plenty of information on the troubles commonly found in dairy herds ; mastitis and abortion have been clearly explained. Some account of husk, which is so troublesome in certain districts of this country, would, however, have been welcome.

The second part of the book consists of an interesting description of the management of a number of dairy farms. Undoubtedly, the farms are chosen to give variety, and the honesty with which the farmers have discussed their various troubles and problems has considerably increased the value of this section. Many farmers have given practical advice on the way in which they themselves have dealt with their problems—a particularly useful feature for those about to start dairy farming. Some of the descriptions of the farms suffer, however, from the fact that no new material appears to have been added since the information was first gathered in 1945.

There are many illustrations throughout the text, but in some instances slightly better photographs might, with advantage, have been sought.

F. H. G.

Poultry Breeding (3rd Edition). Morley A. Jull. Chapman and Hall. 48s.

A comparison of this third edition with the second edition, which was published in 1940, shows how completely Dr. Jull has rewritten his book and brought it up to date. It might almost rank as a new book. Much of the material which had previously been scattered through various chapters has been re-grouped, so that the table of contents appears quite different, and now includes such new chapters as " Gene Linkage", " Fertility and Hatchability", " Viability", and " Meat Production". The revision has been along essentially logical lines, and has brought the picture much nearer to what the practical breeder wants, without endangering its scientific value. References include many on work published up to 1951, and their implications are discussed. The chapter on "Viability" does much to balance the picture of genetic resistance to diseases—a subject widely discussed wherever poultry breeders meet in this country—particularly with reference to lymphomatosis or fowl paralysis. The final chapter on selection methods has been written by Dr. C. S. Schaffner, and brings the foregoing chapters into even sharper perspective for the breeder, but it should not be consulted without reference to the remainder of the text.

W. M. A.

BOOK REVIEWS

Animal Ecology. W. H. DOWDESWELL. Methuen. 12s. 6d.

It is not enough for the field naturalist to observe and describe, collect and identify, as so much of interest and value is lost unless the character of the surroundings is noted and explored. The study of living things is essentially concerned with environment, and whilst knowledge of structure and affinities are of vital importance, an early acquaintance with living animals, through intimate and continuous observations and study of habit and behaviour, can give a better understanding of adjustments, inter-relationships and inter-dependence, and hence a fuller appreciation of function, adaptation and distribution. Too often, however, this approach is neglected or postponed, and it is one of the merits of this book that its intention is to introduce and encourage the study of animal ecology in school sixth forms and first-year university courses. The task is not easy at this elementary level for, owing to the range and scope of the subject and the variety of conditions and factors to be considered, simple, straightforward generalizations are not always possible.

The book contains a useful introduction to the subject, followed by an account of ecological factors in relation to distribution and animal communities in general. The features of particular animal associations, such as parasitism and symbiosis, are surveyed, and the characteristics of land, marine, estuarine and freshwater faunas are outlined. Finally, there is a helpful summary of the commoner methods, techniques and apparatus used in field ecology, and a bibliography.

The subject is well covered therefore, but the treatment is at times too brief, with a lack of adequate explanation and co-ordination, whilst in some cases more familiar and typical examples could with advantage have been chosen. Nevertheless, there is much to commend, both in content and purpose, and this attractive book should prove most valuable and stimulating to young biologists and to those contemplating a biological career.

E. A. S.

Beet Sugar Technology. Edited by R. A. MCGINNIS. Chapman and Hall. 80s.

This book, published under the editorship of R. A. McGinnis, Research Chemist, Spreckles Sugar Company, assisted by a team of specialists, is the first comprehensive work in English on the manufacture of beet sugar to appear for over forty years. It is written to provide a source of instruction, information and reference for all those interested in, or connected in any way with, the beet sugar industry, and in this it can be said at once to fulfil its object admirably. For new entrants to the industry it should prove exceptionally welcome, in that it covers the industry from its early history to the latest processes and chemical engineering methods used today.

In a book of this size the treatment of some sections is necessarily more elementary than could be desired ; for example, " Evaporation and Heat Economy," a subject which has been given a great deal of attention in this country, particularly since the beginning of the last war.

On the other hand, the chapters on " Juice Purification " are most comprehensive, and include an excellent contribution by Dr. and Mrs. Dedek on the " Fundamental Chemistry of Juice Purification." Also included in this section is a chapter on " Adsorbing and Absorbing Agents," covering the use of activated carbons and the Ion Exchange process. It is interesting to learn that, in contrast to this country, nearly half the factories in the U.S. producing white sugar direct from beet, use active carbon in the purification of the thin juice. Nor have ion exchange plants yet been installed in factories in this country. The pros and cons of this process are fairly summed up, and agree with the conclusions reached from investigation here.

The chapter " Growing Sugar Beet " is mostly applicable to the cultivation of the crop under American conditions. Labour-saving techniques and mechanical harvesters are described, and there are subdivisions on Irrigation, Weed Control, Insect Pests and Plant Disease. The short harvesting period in the U.S. necessitates storage of large quantities of beet, and the optimum conditions adopted to limit sucrose losses are dealt with in the chapter " Storage of Beets."

In an account of the diffusion process, a summary is given of Siline's mathematical theory of diffusion, in which are developed equations relating to the various factors affecting diffusion. Descriptions are also given of the types of diffuser in current use, including the Silver, Raffinerie Tirlemontoise, Oliver Morton, Hildebrandt and Raabe continuous diffuser.

Under the general heading of " Crystallization," the subject of vacuum pans, boiling, crystallizers and centrifugals are adequately dealt with. In "Packaging and Storing," an account is given of bag filling and warehousing; whilst in "Special Sugar Products," the transport of sugar in bulk is described, including the specially large portable bins used for this purpose.

Other chapters included deal with " Lime Kilns," " The Boiler House," " Pulp Driers," " Technical Accounting and Process Control," and " Waste Disposal and By-products Recovery." Tightening of anti-pollution laws and water shortage have both caused increased interest in waste water disposal in the U.S.A.

By-product recovery is mostly concerned with recovery of amino-acids from the wash from the saccharate process, to which a chapter is devoted. This process for the recovery of crystallose sucrose from molasses is attractive in America because of a favourable price structure. In European countries the process is of less interest, as molasses are highly valued as a source of alcohol, yeast and stock feed.

In all, no major point of criticism of the book arises ; it is a very readable account of most aspects of American beet sugar production. The drawings and photographs are very well selected and clearly reproduced, and the text has obviously been edited with great care. If, here and there, the treatment is a little elementary, ample references are provided at the end of each chapter for those who wish to pursue the subjects further.

O.H.P.

The Principles of Insect Physiology (4th Edition revised). V. B. WIGGLESWORTH. Methuen. 42s.

Although this scholarly and comprehensive work is primarily intended for students (in the widest sense of the word) of entomology and zoology, it will, as the author remarks in his preface, have considerable interest for many economic entomologists, and it is from this angle that I review it.

It has become increasingly evident during the past decade or so that *ad hoc* research in insect control methods has its limitations and that there are many problems which are unlikely to be solved until certain fundamental questions in the realms of insect physiology and ecology have been answered. Although such studies are not perhaps likely to yield spectacular returns in the immediate future, there are many possible applications. The action of insecticides is one of the most obvious ; and indeed, many studies on the egg, the integument, the digestive and respiratory systems have already been inspired by this object. In some cases physiology has provided the explanation of some time-honoured observation in the same way that agricultural scientists have explained the reason for a traditional practice. Thus, on p. 210, it is stated that the earwig " shows photokinesis, thigmotaxis, hygrokinesis and negative geotaxis ; responses which will explain the normal hiding places of earwigs and are utilized by gardeners when they trap earwigs in flower-pots containing dry straw inverted on canes."

In its arrangement the revised edition closely follows the original. After an opening chapter on the egg, the integument is dealt with as a necessary preliminary to the (third) chapter on growth and metamorphosis. Then follow chapters on the muscular and nervous systems and the sense organs, leading up to a chapter on behaviour. The remaining chapters discuss respiration, the circulatory system, digestion and nutrition, excretion, metabolism, water balance and temperature relationships, and finally reproduction. A considerable amount of space is inevitably taken up with anatomy and histology, for one cannot consider function without describing form.

Within convenient sub-headings for each chapter, the facts are set out clearly and precisely, each with its appropriate reference to the original source of information. Indeed one cannot but admire the skilful way in which a mass of detail has been welded together with economy of words into a surprisingly readable account for anyone more or less familiar with biological jargon.

This is no formal revision with an odd amendment here and an additional paragraph there. The amount of work done on this subject during the past dozen years or so is indicated by the fact that the number of references at the end of each chapter (averaging nearly 200) has increased by about 50 per cent on the first edition. This has meant that much of the book has had to be rewritten, and it is remarkable in these days of specialization that one man has not only compassed such a vast field but has also been actively engaged in research into most aspects of it.

Despite the wide scope of the book, there are one or two omissions. For example, there is scarcely any mention of oviposition responses and the factors causing them. Another point which strikes the applied entomologist immediately is the physiologist's habit of referring to organisms by their generic names only. Even if one admits that the physiology of one species is likely to be similar in most respects to that of another species in the same genus, entomological nomenclature is so confused that a reference to *Laspeyresia*, for example, may suggest the Pea Moth, the Codling Moth or the Oriental Fruit Moth (to name a few of the important pests sometimes assigned to this genus) all of which may be referred to four or five other genera. Also where specific names are given the addition of

the authority would reduce the possibility of confusion, particularly in such groups as the aphids. These, however, are minor criticisms and do not detract from the value of the book which is of the high standard that one would expect from Dr. Wigglesworth.

The book is well indexed and there are numerous line drawings. It is remarkably free from typographical errors : " regpugnational " for " repugnatorial " on p. 401 was the only one noted. The publishers may also be congratulated on the style and production, and in these hard times the book is good value at two guineas.

H.C.G.

Principles of Weed Control. G. H. AHLGREN, G. C. KLINGMAN and D. E. WOLF. Chapman and Hall. 44s.

Today there is a world-wide interest in the new techniques of weed control, and this interest is shared by the scientist, the chemical manufacturer, the agricultural engineer, the spraying contractor and the farmer. Every year some hundreds of scientific papers are published which relate to the more fundamental aspects of toxicity. Every year in the United States alone four regional conferences are held, at which the attendance may be anything up to 500 people and where the main emphasis is on the practical usage of herbicides. Against this background it is clear that the writing of a book on weed control is a formidable task. In the first place, the book may well be, at least in part, out-of-date by the time it is published. Secondly, no single volume can be comprehensive enough to cover all aspects and all countries. Some limitation in scope is therefore inevitable, and the authors of *The Principles of Weed Control* are concerned with the means and methods of weed eradication under American conditions, and state in the preface that though they have " primarily written for classroom instruction they sincerely believe that this book will prove useful to research specialists . . . farmers . . . herbicide sales representatives . . . and vocational agriculture teachers."

This restriction to American experience and American sources limits the appeal of the book to English readers, especially to those seeking information which is applicable to their own weed problems. For example, comment on 2-methyl-4-chlorophenoxy-acetic acid (MCPA) which is so widely used in Great Britain and Europe is confined by giving the formula and seven lines of print including the statement that " it is similar to 2,4-D in herbicidal properties." On the other hand, British and European workers have found that for crops like linseed, MCPA is far more selective ; indeed, recent results from America have confirmed this finding.

While most of the book is devoted to methods of control and methods of application, there are two chapters dealing with the chemistry of herbicides and their mode of action. Since in these fields of research there are no boundaries between countries, the discussion would have greatly benefited had more reference been made to work outside the U.S.A. For instance, there is no mention of the important papers by the Swedish workers, Aberg and Eckdahl, on the mechanism of chlorate toxicity.

The authors appear to be rather uncertain as to the standards required for classroom instruction. At some points the chemistry and botany are quite involved, while on other pages the most elementary concepts are explained, such as " sodium pentachlorophenate is the sodium salt of pentachlorophenol "—followed, incidentally, by a serious misprint in the next sentence. These explanations will, however, be of benefit to farmers and others who wish to know something of the developments and practice of weed control that have taken place in America during the post-war years up to 1950.

G.E.B.

Surrey Naturalist. ERIC PARKER. Hale. 18s.

Mr. Eric Parker will be remembered by many readers as the eloquent author of the " County Series " book on Surrey. Here he invites more detailed attention to some of his favourite haunts. The book is rich in natural history experience, reminiscences and reflections. His subject matter is diverse—from the changes that have taken place in the Surrey countryside during the past hundred years, to speculation on the apparently aimless wanderings of the black ant and on the queer taste for paper suddenly developed by tits in 1948. Interesting information has been gleaned from the writings of the older Surrey naturalists, whence it is learned that black game was once common in the county ; it has disappeared with the spread of built-up areas. From letters written by Matthew Arnold it is suggested that the poet may originally have been responsible for the introduction of that pest the grey squirrel.

There is an interesting description of the "Swallows" of the River Mole, and exciting adventures in the garden. I felt with the author the thrill of seeing for the first time the Convolvulus Hawk Moth, and of realizing that in seeing a wasp carrying a green caterpillar

he was observing exactly the same experience that John Ray described nearly three hundred years ago. I sympathized with his loss when the birds for which he attempted to maintain a sanctuary were steadily decimated by the depredations of a sparrow-hawk.

And so Mr. Parker discourses on this and that, with never a dull moment. Text and illustrations make *Surrey Naturalist* a delightful book for the country-lover.

E. M. W.

Milk Production Per Acre. Bulletin No. 2. Agricultural Development Department. Imperial Chemical Industries Ltd. Free.

In this era of greater striving after self-sufficiency and maximum production, any information that will help us to get more gallons to the acre is of the greatest interest to farmers. This study emanating from I.C.I.'s post-war agricultural development programme is based on the cost accounts of sixty-one farms—55 in England and Wales, 5 in Northern Ireland and 1 in south-west Scotland. From their knowledge of the average stocking of cows over a complete year and the corresponding production of milk, feedingstuffs consumption, and crop and grazing records, the authors have attempted to assess the acreage to be attributed to the dairy stock. They allow for the upkeep of the bull, and take into account the rearing of cow replacements by attributing an acreage to rearing. They also show the combined area attributed to cows and replacements. Since, however, replacements are capable of being switched from milk to meat, the production of this area is in the form of meat as well as milk.

On the average, the cropping records of the sixty-one farms showed that the grass area is four times as large as the area of fodder crops, of which oats is the most important, followed by " other brassicas ", mainly marrowstem kale.

It is shown that the predominantly dairy farms produce more gallons per acre and, in spite of a smaller tillage acreage serving the cows, they also manage with less grass. In other words, they use their land much more intensively than those farmers whose dairying is supplemented by other enterprises. More cows per acre means more gallons per acre, and this in turn means lower feed costs per gallon—an all-round benefit.

This booklet is well worth study by the progressive dairy farmer interested in producing the maximum quantity of high quality feed, and hence more milk, from his limited acres.

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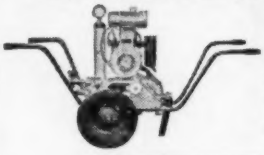

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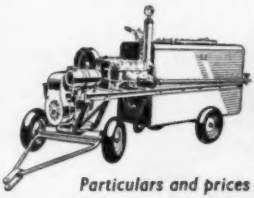

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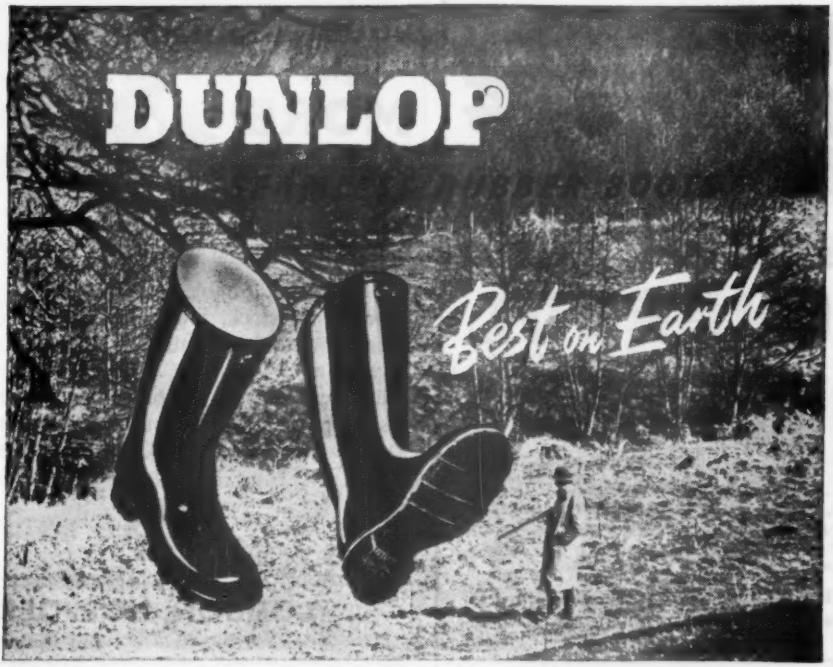

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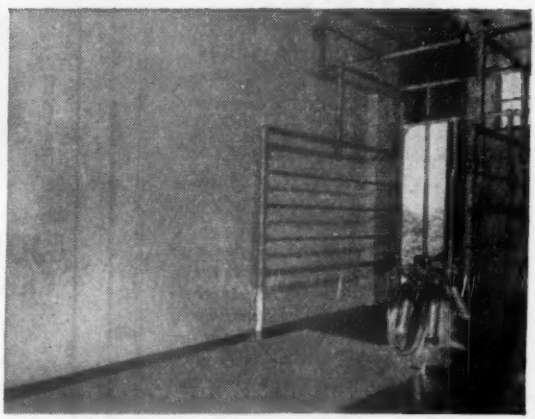

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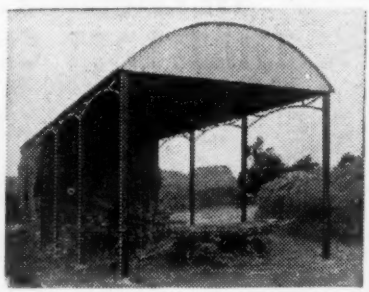

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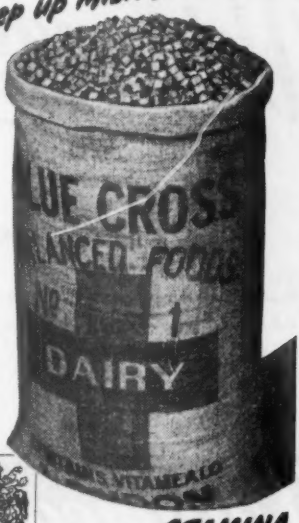

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